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COOPERATIVE RUNOFF AND SEDIMENT INVESTIGATIONS ON MEDICINE CREEK WATERSHED IN NEBRASKA

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COOPERATIVE RUNOFF AND SEDIMENT INVESTIGATIONS ON MEDICINE CREEK WATERSHED IN NEBRASKA[1]

V. I. Dvorak and H. G. Heinemann[2]

INTRODUCTION

Comprehensive data were collected during the period 1951-58 to determine the important weather, soil, channel, geomorphologic, and topographic factors as related to the damage caused by flood, sediment, and erosion in the Medicine Creek Watershed of southwestern Nebraska This collection was under the sponsorship of the following agencies:

Agricultural Research Service, U.S. Department of Agriculture
Bureau of Reclamation, U.S. Department of the Interior
Geological Survey, U.S. Department of the Interior
Soil Conservation Service, U.S. Department of Agriculture
Nebraska Agricultural Experiment Station

Data collection contributions of the participating agencies are summarized in table 1.

This report constitutes a compilation and summary of the data and information obtained and was prepared in fulfillment of, and in accordance with, a commitment made by the Agricultural Research Service at the sponsoring agencies' Advisory Group Meeting on July 22, 1958.

Some limited analyses and interpretations are included to indicate data significance or limitations. Complete detailed analyses or interpretations on any particular aspect are left to the individual agencies or others. Generally, the period of record and sequence of hydrologic and climatic events during the investigation were so atypical (one wet year, five very dry years) that firm conclusions cannot be established.

DESCRIPTION OF THE WATERSHED

Medicine Creek Watershed is triangular in shape and narrows in a southeasterly direction to the apex at the confluence of Medicine Creek and the Republican River (fig. 1). The creek heads in Lincoln and Hayes Counties and flows southeast through Frontier, Red Willow, and Furnas Counties before joining the Republican River near Cambridge, Nebr. The drainage area above Harry Strunk Lake is 660 square miles, and the total drainage area of Medicine Creek is 680 square miles above the confluence with the Republican River. Because of the homogeneity of the basin, a generalized description of climate, land use, and soils is presented of Medicine Creek Watershed with shape, size, and drainage characteristics described for each gaged subwatershed.

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[1] Soil and Water Conservation Research Division, Agricultural Research Service, USDA, in cooperation with the Bureau of Reclamation and the Geological Survey, U.S. Department of the Interior; the Soil Conservation Service, USDA; and Nebraska Agricultural Experiment Station.

[2] Hydraulic engineers, ARS, USDA, at Hastings, Nebr., and Columbia, Mo., respectively.

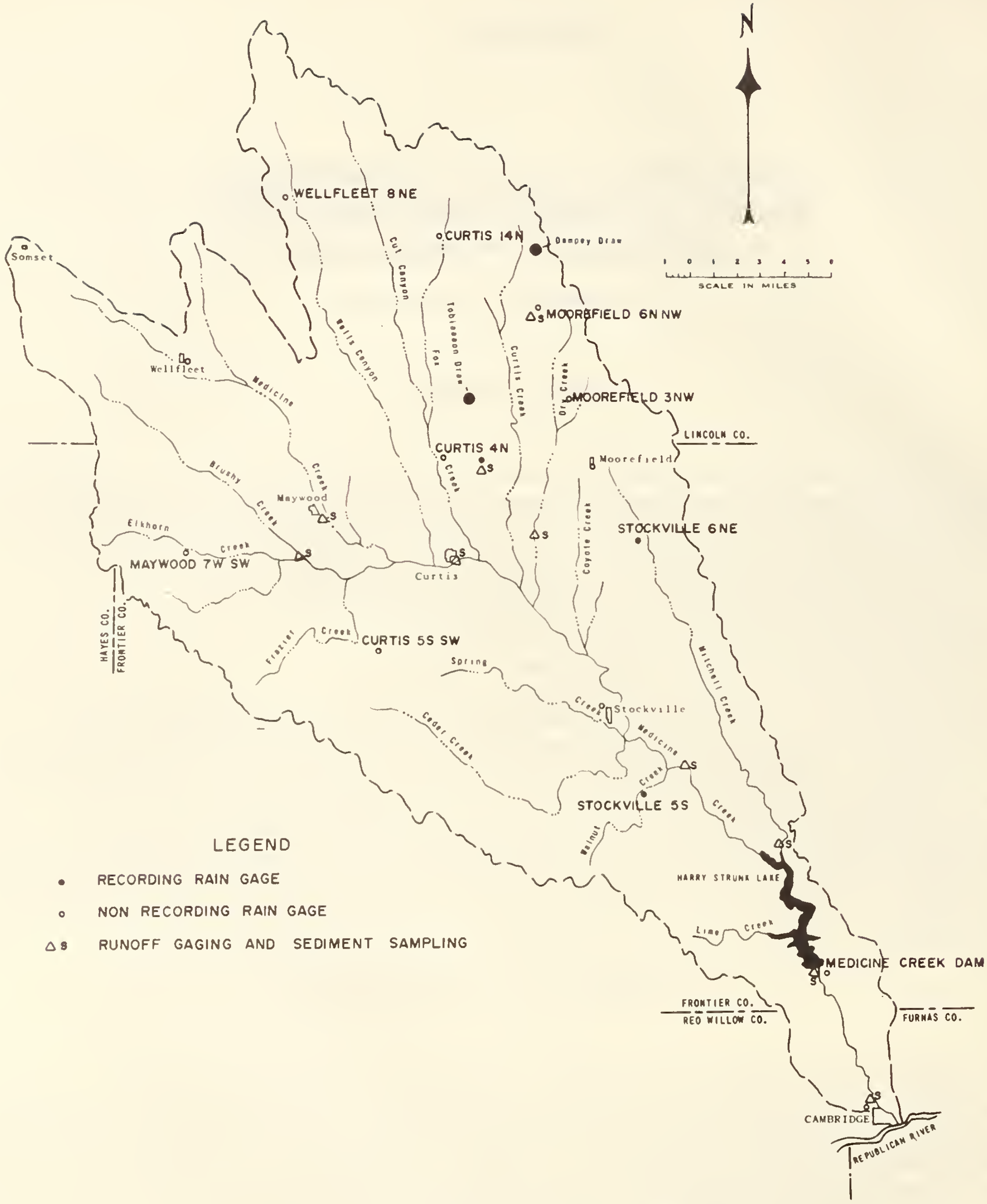


Figure 1.--Medicine Creek Watershed, Nebr.

Physiography

The Medicine Creek Watershed is in the Great Plains Physiographical Province (4) and was originally part of a smooth, gently eastward-sloping loess-mantled plain. Erosion in this watershed greatly changed the old plainlike surface and produced a well-developed drainage system with steep adjacent land slopes separated by narrow flat-topped remnants of the old plain. Few of the remnants exceed a mile in width. Between the major drainageways, the divides are continuous and have numerous spurs, some of which extend out many miles.

The major streams and their principal tributaries (apparently very youthful) are entrenched from 100 to 200 feet below the original flat-topped plain, and occupy very narrow valleys separated from the flat ridges by short, steep slopes. Soil slipping, which is common on these steeper slopes, results in terracelike shelves called steps, cat steps, or terracettes. The steps and their effect on sediment yield have been studied and described by Brice (2).

The Medicine Creek Watershed was divided into 15 subwatersheds for study and data collection and are indicated on figure 2. Since most of the work was done on 9 subwatersheds, these are described in greater detail in the following sections.

Brushy Creek

The Brushy Creek gaged subwatershed, 72 square miles in area, is formed by three almost equal-sized tributaries. Each tributary is 2 to 4 miles wide and about 9 miles long. The tributaries have deeply entrenched valleys with both continuous and discontinuous gullies (10) up the valley sides. The North Branch has an aged and stable channel with trees growing along the banks. In places near the headwaters in this branch, there are marshes with associated vegetation. The South (actually middle) Branch channel is eroding, and an overfall has cut halfway through this drainage. The eroded channel is nearly 20 feet deep and 40 to 80 feet wide. In the Elkhorn tributary, southernmost branch, the incised channel has several overfalls or is in the first coalescence stage. A small channel near the headwaters is still stable with trees and grass growing on bottom and banks.

Medicine Creek above Maywood

The upstream drainage area boundary of the Medicine Creek above Maywood subwatershed is difficult to determine because of an adjacent sanddunes area which has no definite drainage system. The subsurface drainage area is probably considerably larger than the surface area (74 square miles) because of the sanddunes and the underlying geologic formations, which slope southeast. This is the first stream south of the Platte River--25 to 35 miles away--to intersect waterbearing strata.

The runoff and sediment station was established near Maywood at old Highway 83, and this determined the lower subwatershed boundary. The sloping banks of the channel above this station are covered by willows and other deciduous trees. The stream is fed by numerous springs and seeps emerging from the channel banks. Upstream, toward the village of Somerset, the valley is not entrenched so deeply, and the channel is smaller. Near Somerset, the channel is not well defined and consists of a series of marshes and swamps. There is no active erosion in the main channel, but numerous discontinuous gullies have been eroded on the valley slopes.

Wells Canyon

The Wells Canyon subwatershed is 2 to 4 miles wide and 24 miles long (55 square miles of drainage area) and is east of the dune area. The valley in Wells Canyon has entrenched, as have the other valleys in Medicine Creek Watershed. A channel extends only about one mile upstream from the valley mouth. Downstream the valley bottom is about one-half mile wide and is covered

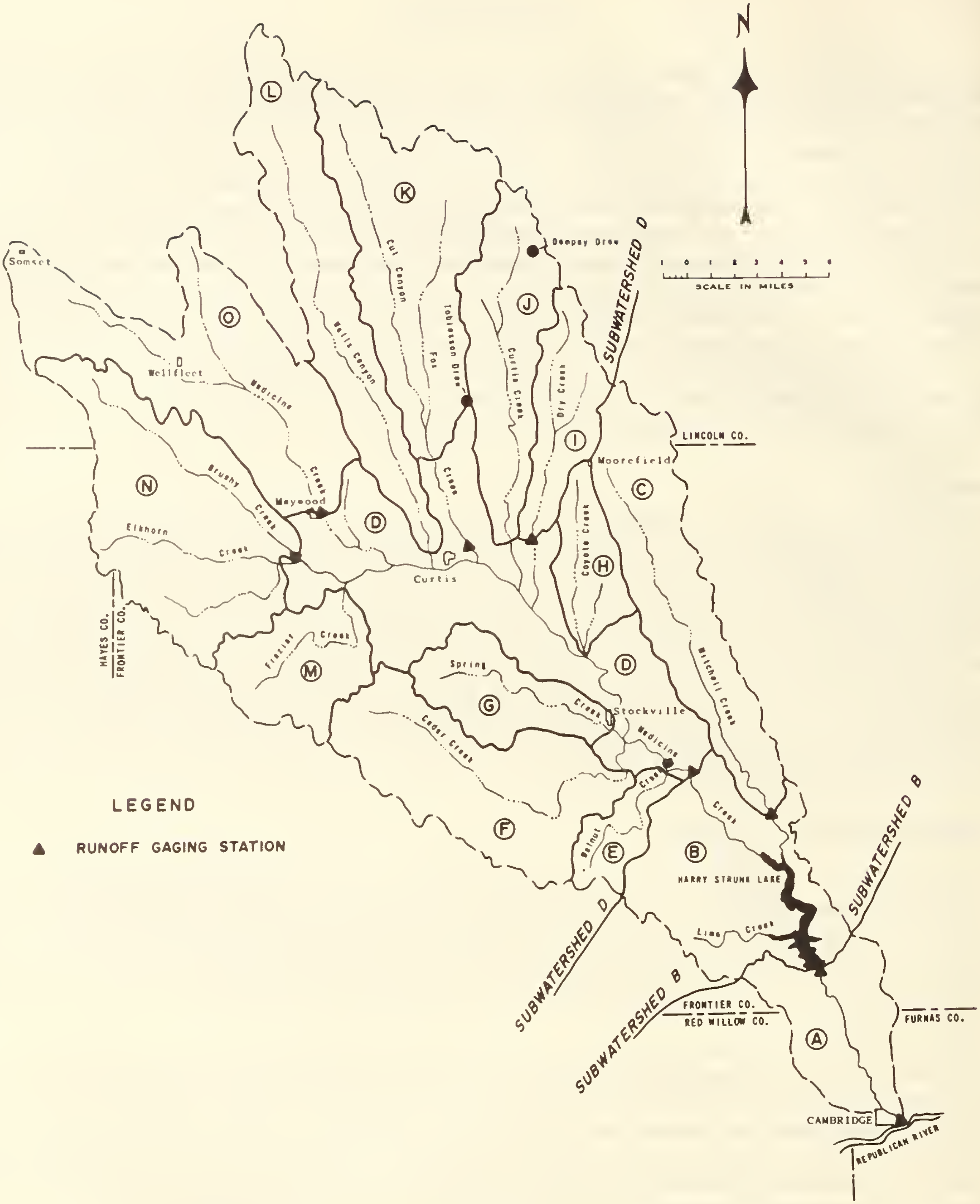


Figure 2.--Subwatersheds in the Medicine Creek Watershed, Nebr.

by trees, grasses, and bushes. In many places this valley has been cleared and cultivated, apparently without damage from frequent floods. Discontinuous gullies are found on the steeper side slopes of the valley.

Fox Creek .

The Fox Creek drainage area (73 square miles) is 20 miles long, and the width increases from 3 miles near the mouth to 6 miles in the headwaters area. Unlike the adjoining Wells Canyon to the west, Fox Creek has a well-developed stable channel. The channel carries perennial flows, and the large trees growing along the banks indicate that they have sufficient moisture. Upstream about 5 miles from the gage, two tributary channels--Cut Creek and Fox Creek--join to form the main Fox Creek. Each of these two tributaries also has a perennial flow and stable channel conditions. There are a few discontinuous gullies throughout this watershed, but grass and tree growth has apparently prevented severe erosion, especially in the northern portion of the drainage. The grass cover in this headwaters area is probably the best in the Medicine Creek drainage. Also, in this area, a large number of deciduous and coniferous trees grow on valley bottoms and side slopes.

Dry Creek

The small Dry Creek subwatershed is about 3 miles wide and 13 miles long and has 20.5 square miles of drainage area. It is markedly different from the other subwatersheds already described because gully and channel erosion is extremely active. The upstream channel has several overfalls which are spaced about a half-mile apart. Continuous gullies have developed from the incised channels up the valley side slopes to cultivated lands on the level divides. Discontinuous gullies have also developed on steep slopes adjacent to streams throughout the watershed.

From the observed water elevations in domestic and irrigation wells, the water table is nearly 50 feet below the channel bottom in most of the subwatershed. Trees and grass in this drainage do not indicate a high water table. Runoff in measurable amounts occurred in this channel about 5 percent of the time between 1951 and 1958.

Mitchell Creek

Mitchell Creek subwatershed (52 square miles) forms the east boundary of Medicine Creek Watershed and drains directly into Harry Strunk Lake. It is approximately 3 to 4 miles wide and 20 miles long. Its valley is not entrenched as deeply as those of other watersheds, and its valley side slopes are not steep.

The incised channel is deep and narrow with vertical banks. A few trees and shrubs grow along the banks. Both continuous and discontinuous gullies in all stages exist throughout this subwatershed.

Tobiassen Draw

The Tobiassen Draw drainage area is located upon the old loess plain between Fox and Curtis Creeks in sec. 4, T 8 N, R 28 W. The drainage area is 0.34 square mile to the road culvert. From this area, it was thought that typical runoff and erosion data could be collected from upland cultivated fields.

Dempcy Draw

Dempcy Draw is a half-square-mile drainage area located in upper Curtis Creek near the Dry Creek divide in sec. 6, T 9 N, R 27 W. Because of steep slopes, 90 percent of the area is used for grazing. A stockwater pond in the valley provided a suitable site for collecting sediment and runoff data from the small grazed area. Discontinuous gullies are conspicuous in this subwatershed.

Soils

The soils of the watershed have high moisture-retaining capacities, an abundance of lime, and are easily penetrated by air, moisture, and plant roots. These soils of the watershed have been classified (1) by internal and external characteristics according to series and types. The important series in this watershed are the Holdrege, Hall, Colby, Bridgeport, and Laurel. The Hall and Bridgeport are terrace soils and Laurel is bottom-land soil. The two principal soil types within the several series are silt loams and very fine sandy loams.

During the present Medicine Creek investigations, the Soil Conservation Service made a conservation survey of the watershed. This survey delineated homogeneous areas of soil, slope, erosion, and land use. No summarization is available. Copies of this survey are filed in the State Soil Conservation Survey office in Lincoln.

Climate

The climate is continental and has large seasonal extremes. Summers are warm, and winters are moderately long and cold. There is considerable rain during the spring, while the fall season has moderate temperatures and occasional rainy periods.

The annual precipitation varies greatly from year to year, with measured extremes from 8.63 to 38.25 inches at Curtis, Nebr., near the center of the watershed. The average annual rainfall at Curtis was 21.36 inches from 1895 to 1958. The mean monthly temperatures varied from 26 degrees in January to 78 degrees in July, while the recorded temperature extremes were -33 degrees in December 1919 and 113 degrees in June 1952.

Land Use

The first agricultural use of the watershed, was the grazing of cattle herds en route from Texas to Ogallala, Nebr. in the early 1860's. The first permanent settlements were established in the early 1870's in the Medicine Creek Valley. Settlement was relatively rapid, and by 1900 most of the desirable land was claimed under the Homestead, Timber Claims, and Pre-Emption Acts.

The present land use is divided into two principal categories: 25 percent of the land is cultivated and 67 percent is pastured. On the cultivated land the important cash and feed crops are wheat, corn, and sorghum. Only a small portion of the harvested grain is fed to livestock within this watershed. The grain yields are high where irrigation wells have been developed (on flat ridges) and where crops have been properly fertilized. In dryland areas, grain fields are summer fallowed alternate years to conserve soil moisture and increase the yields.

The pastures are on the steeper and rougher topography and consist of native species--bluestems, sandgrass, buffalograss, and others.

PRECIPITATION AND STREAMFLOW MEASUREMENTS

The locations of the stations in the precipitation and streamflow network were chosen according to suitability of local physical and cultural conditions, acquisition of maximum information with funds available, and availability of observers. The station locations are shown on figure 1.

Precipitation Stations

A network of recording and nonrecording precipitation gages was operated for various periods as shown by table 2. The recording gages were usually in or near subwatersheds with runoff-sediment gaging stations. The records for all stations are filed at the Weather Bureau office in Lincoln, and most are included in U.S. Department of Commerce, Weather Bureau publications of "Hourly Precipitation Data", and "Daily Precipitation Data, 1951 to 1958", inclusive (20). Numerous precipitation stations were located throughout the watershed, as shown on figure 1.

In addition to the above standard recording and nonrecording gages, the Geological Survey, with the assistance of local farmers and ranchers, maintained small-diameter gages in the Dry Creek subwatershed for the period 1952-54.

Runoff and Suspended-Sediment Gaging Stations

Daily runoff and suspended-sediment discharges were measured at seven locations from 1951 to 1958, inclusive. In addition, periodic measurements were made of the suspended sediment discharge through the outlet works and over the spillway of Medicine Creek Dam. Two additional runoff and sediment stations in Tobiassen and Dempcy subwatersheds were established in 1953 to obtain information on sediment yield from upland sheet erosion and gullies.

Runoff samples were used to obtain records of suspended-sediment discharges collected with standard sediment-sampling equipment. Streamflow and sediment-discharge measurements were made weekly by Geological Survey engineers, with additional measurements on major streamflow rises. During periods of significant flow, samples were collected by the local observers or by Geological Survey personnel. At selected stations, some bed-material samples were collected for use in total sediment-load computations. The stage-discharge relationships were fairly well defined; however, because of the nature of the streams, significant shifts in the rating curves occurred during each major rise.

All computed daily runoff and suspended-sediment discharges, except those for Tobiassen Draw and Dempcy Draw stations, were published in Geological Survey Water Supply Papers (18). The data for Tobiassen Draw and Dempcy Draw stations are shown in appendix tables 13 and 14 respectively. The records for these stations are filed in offices of the Geological Survey in Lincoln. The stations are listed in table 3 with drainage areas and dates of operation.

EROSION AND SEDIMENTATION STUDIES

Erosion and sedimentation studies provided information on: (1) the sediment yield of Medicine Creek Watershed and selected subwatersheds, (2) the sources of sediment with respect to tributaries, and (3) the relationship of channel and gully erosion to suspended-sediment discharge in Dry Creek.

The suspended-sediment yields were computed by cumulating the daily sediment discharges from gaging stations. If these yields are compared, the tributaries with large sediment sources can be identified.

The representatives of the cooperating agencies recognized that upland sheet and gully erosion data would help in determining sediment sources in the Dry Creek Watershed. After a 1953 field reconnaissance in and near Dry Creek, the representatives selected the Tobiassen and Dempcy farm areas as representative of the uplands. Tobiassen farm is entirely cultivated, and about half of the area is terraced. A rotation of wheat and fallow is followed. At a road culvert near the Tobiassen farm, the runoff was gaged and suspended sediment was sampled from 1953 through 1958. These data are shown in appendix table 13. In 1953 a topographic map was made of the area above the gage because backwater at high discharges resulted in ponding and deposition upstream. The sediment yield was not estimated, because the sediment deposition above the gage was not determined at the termination of gaging. Sediment data for Tobiassen and Dempcy farms are available at the Geological Survey office in Lincoln.

In Dempcy pond watershed, 90 percent of the area is in grass. Land slopes are steep and the small watershed contains many gullies. The soils are classified as the broken phase of Colby very fine sandy loam. The stockwater pond was built in 1948.

Sedimentation surveys of Dempcy pond were made in July 1953 and June 1958. The 1953 survey was made jointly by the Geological Survey and the Soil Conservation Service, at which time permanent range ends were monumented to facilitate future sediment surveys. The pond area and capacity curves, contour maps, a map showing sediment depths, and other basic data from the 1953 survey are available at the Geological Survey, Quality of Water Branch in Lincoln. During the second survey, Agricultural Research Service personnel determined the volume of deposited sediment and collected sediment samples above and below the water level. The data for this second survey are filed in offices of the Agricultural Research Service, Northern Plains Branch, in Hastings. Results of these surveys are shown on the Reservoir Sedimentation Data Summary sheet appendix table 15.

The runoff to Dempcy pond from 1953 through 1958 was determined by the changes in stage of the reservoir. These previously unpublished runoff data are summarized in appendix table 14.

In Dry Creek, channel erosion was measured because of its suspected importance as a source of the suspended-sediment yield. In the channel erosion study, an "item" is defined as a valley reach in which there may be from 1 to 50 cross sections. These items were selected to be representative of the channel system. The locations are shown on figure 3. Most of the items were originally surveyed and monumented in 1951 by the Bureau of Reclamation, with resurveys in 1952 and 1956. (Items 3a, 8f, and 10a were established in 1953, item 10b in 1956, and remaining items in 1951.) Each item was marked with three concrete monuments having brass caps. Appendix table 16 lists the item stationing and survey dates. The field notes for the channel erosion surveys are filed at the Bureau of Reclamation office in McCook.

Geological Survey and Bureau of Reclamation personnel collected 62 undisturbed soil samples from the valley terraces, gullies, and main channel of Dry Creek. These samples were used to convert the measured volumes of channel erosion to weights so that the erosion could be compared to suspended-sediment yield. For each sample, they determined the particle-size distribution and volume-weight. These values are tabulated in appendix tables 17 and 18.

Personnel of the Bureau of Reclamation surveyed Harry Strunk Lake in October 1951 (17) and December 1962 and provided the summary shown in appendix table 19. Field data from this survey are on file in the Bureau of Reclamation office at McCook.

Data were obtained for (1) determining drainage areas of upland gullies and minor tributaries, (2) analyzing quantitatively the geomorphic landform and drainage density, (3) relating measured stream gradients and longitudinal and transverse profiles of alluvial or valley terraces along Medicine Creek and selected tributaries with changes in regimen, (4) preparing an areal map of valley terraces, and (5) correlating these terraces by elevation and by stratigraphy. In addition, petrographic studies made at selected sites provide information on the structural and textural properties of the loess mantle. This work was accomplished by the Agricultural Research Service and the Geological Survey.

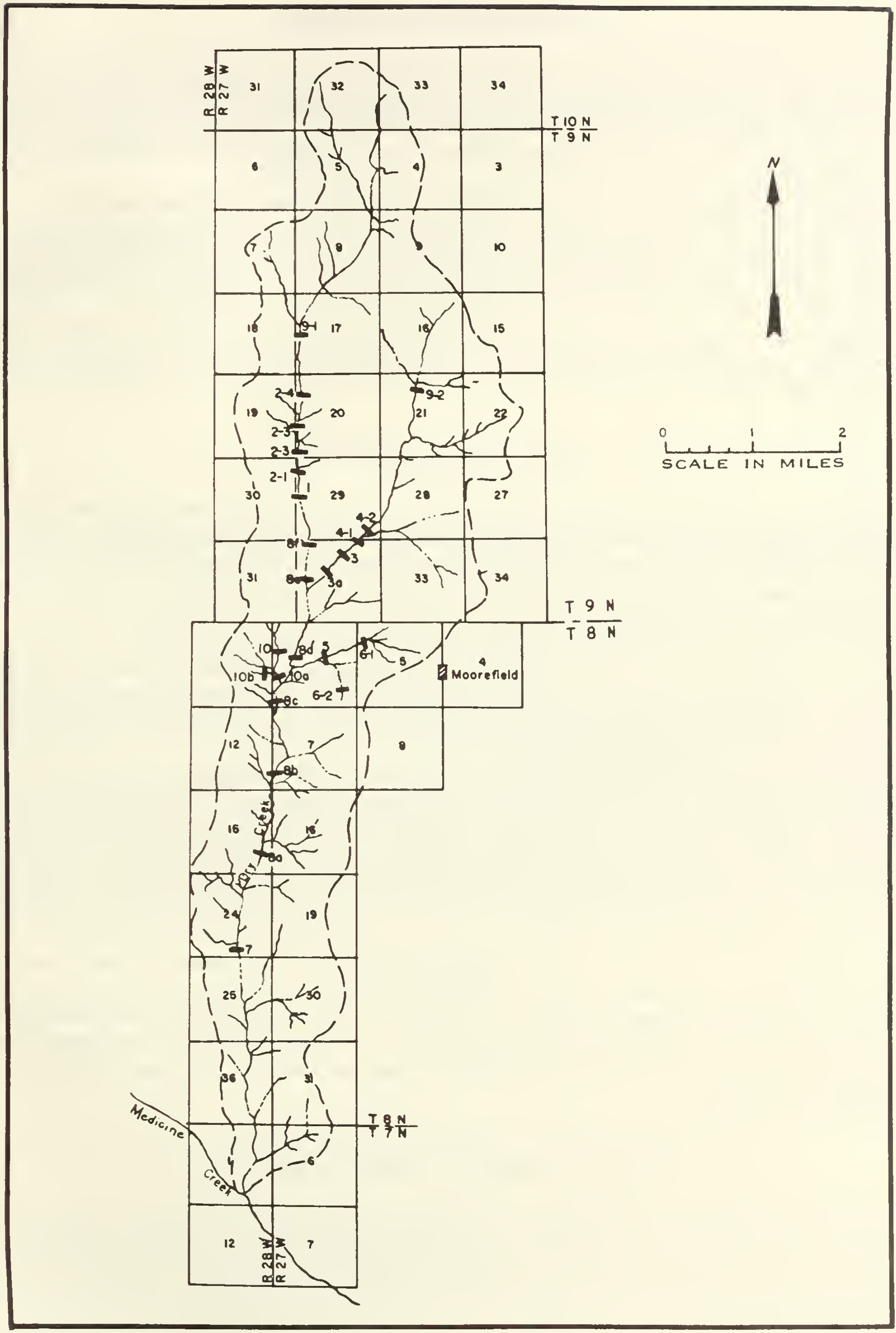


Figure 3.--Dry Creek channel erosion survey.

GEOMORPHIC STUDIES

In 1953 and 1954, geomorphic studies were made on the changing topographic features in Dry Creek, such as headcuts, gullies, and terracettes. In these studies, information was obtained from field observations and measurements, aerial photographs, carbon datings, and stratigraphic relations. Utilizing the results of these studies, Brice (2) described the significance of steps in erosion and sediment yield.

Additional analytical materials are available from the Geological Survey office in Lincoln. Two other reports were written by Brice, a preliminary report and an open-file report.

A preliminary report released in 1953, "Erosion by Upland Gullies in the Dry Creek Drainage Basin, Nebraska," summarizes the quantitative data on upland-gullies erosion between 1937 and 1952.

An open-file report distributed in 1955, "Geomorphology of Dry Creek Drainage, Nebraska," describes the physiographic history of Dry Creek as developed from an analysis of the complex terrace sequence.

LAND-USE SURVEYS

The Soil Conservation Service and the Agricultural Research Service cooperated in making land-use surveys of the entire Medicine Creek Basin in 1954, 1955, 1956, and 1957. The Soil Conservation Service furnished a set of 215 aerial photographs taken in 1951 and 1952 and provided an airplane and pilot. The Agricultural Research Service furnished an observer for mapping, made areal measurements of each field, and tabulated the results of the surveys.

Prior to the field operations, the photographs--scale 1 inch equals 1,320 feet--were arranged in a flight pattern across the drainage area and were numbered consecutively, and the portion to be mapped on each picture was outlined. In the field operation, the plane followed the flight pattern and circled each pictured area long enough to permit visual delineation of all field boundaries and to determine the land use.

The Medicine Creek Watershed was divided into 15 subwatersheds for tabulation and summarization of records. These subdivisions are shown on figure 2. Subwatershed A includes all the drainage area above the stream gage at Cambridge. Subwatershed B includes all the drainage area whose runoff drains into the Harry Strunk Lake. Subwatershed C is limited to Mitchell Creek and includes all the drainage area above the Mitchell Creek gaging station. Subwatershed D includes all the drainage area of Medicine Creek above the gage at the head of the lake. The other subwatersheds consist of the drainage areas of the principal tributaries of Medicine Creek, including a separation for each of the watersheds where runoff and sediment records were obtained.

The acreages of each land use and their percentage of total area in the subwatersheds are summarized by years in appendix tables 20 through 27. The detailed data of the land use for 1954, 1955, 1956, and 1957 are available at the Agricultural Research Service in Hastings. In addition, the Service also has 1951 and 1952 land-use inventories and 1952 range-condition surveys for Dry Creek subwatershed.

SOIL CONSERVATION SURVEY

A soil conservation survey delineated the homogeneous area of soil, slope, erosion, and land use. The survey's objective was to provide physical facts to determine proper land use. The survey also furnished soils and related information to Soil Conservation Districts for planning and establishing conservation practices on individual farms.

The survey was started in the Dry Creek subwatershed in 1951, and by 1957 the entire watershed had been surveyed. These homogeneous areas were outlined on 40 aerial photographs. The State office of the Soil Conservation Service has originals and reproductions of this information in Lincoln.

TOPOGRAPHIC SURVEYS

The field work for topographic mapping of the Medicine Creek Watershed was completed in 1955. The maps are now available from the Geological Survey, Federal Center, Denver, Colo. Quadrangle maps are as follows:

Quadrangle	Contour Interval feet
Maywood 1 NE, SE, SW, NW	20
Maywood 2 SE, SW	10
Maywood 3 NE	20
Maywood 4 NE, SE, SW, NW	20
Gothenburg 2 SW	20
Gothenburg 3 NE, NW	20
Gothenburg 3 SE, SW	10
McCook 1 NE, NW	10
Bartley 1 SW, NW	10
Bartley 2 NE, SE, NW	10

From these maps, the relief ratios, drainage densities, stream order numbers, and hypsometric curves, were determined for geomorphic and hydrologic comparisons between subwatersheds.

DATA COMPILATION AND ANALYSES

Analyses of the cooperative study data were made to determine relationships and interrelationships between sediment yield and precipitation, runoff, gully and channel erosion, and drainage-relief ratios. In addition to data collected from 1951 through 1958, supplemental precipitation data were available for Curtis, Nebr., from 1894, and runoff data for Cambridge, Nebr., from 1937. From long-term runoff and precipitation data, the average annual runoff and sediment yields were estimated for each of the six subwatersheds by several different methods.

Included in this report are studies of channel regime, unmeasured sediment transport, and comparison of suspended sediment to deposited sediment in Harry Strunk Lake.

Precipitation

Precipitation in this semiarid location varies widely within and between seasons and years. At Curtis, Nebr., which has the longest precipitation record within the watershed, the annual rainfall extremes were 8.63 inches in 1894 and 38.25 inches in 1915 (table 4). The monthly amounts ranged from zero or traces to 9.14 inches in June 1947. When the precipitation data collected during the study were compared with the data of 1894 to 1958, major differences were found for average annual and monthly precipitation and frequency of occurrences.

The accumulated departure of annual precipitation from the mean for Curtis, Nebr. is shown on figure 4. From 1895 until 1915 the average annual precipitation was predominantly greater than the long-term mean and resulted in a large positive departure. There was a general negative departure after 1915, with the steepest descent in the 1950's.

The average annual precipitation was 18.82 inches from 1951-58 and 21.36 inches for 1894-1958. The driest continuous period of record was for 1952-56. This exceeded the previously recorded drought of the 1930's.

The average precipitation by months for the 1951-58 period was lower for each month than the 1894-58 period, as shown on figure 5. The only months that were near the long-term average were May and June.

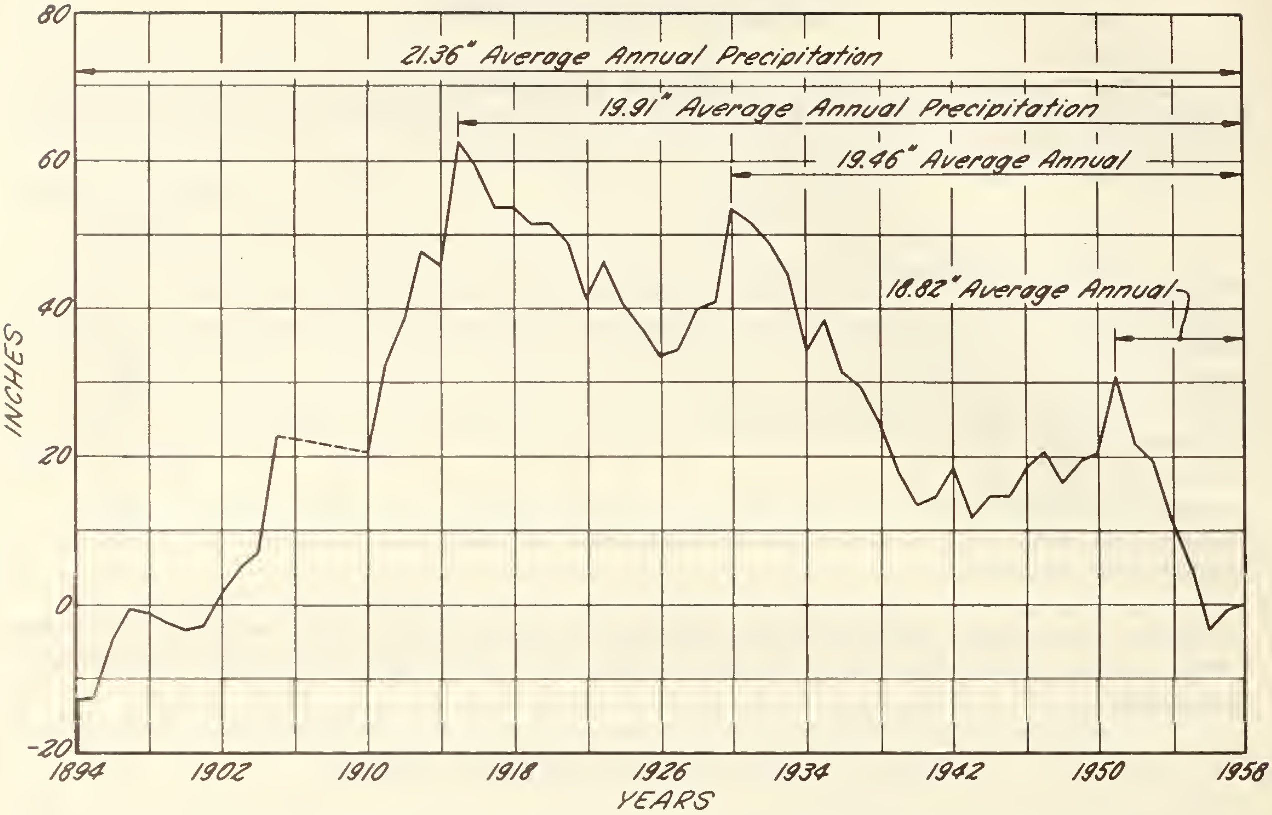


Figure 4.--Accumulated departure of the annual precipitation from the mean for Curtis, Nebr.

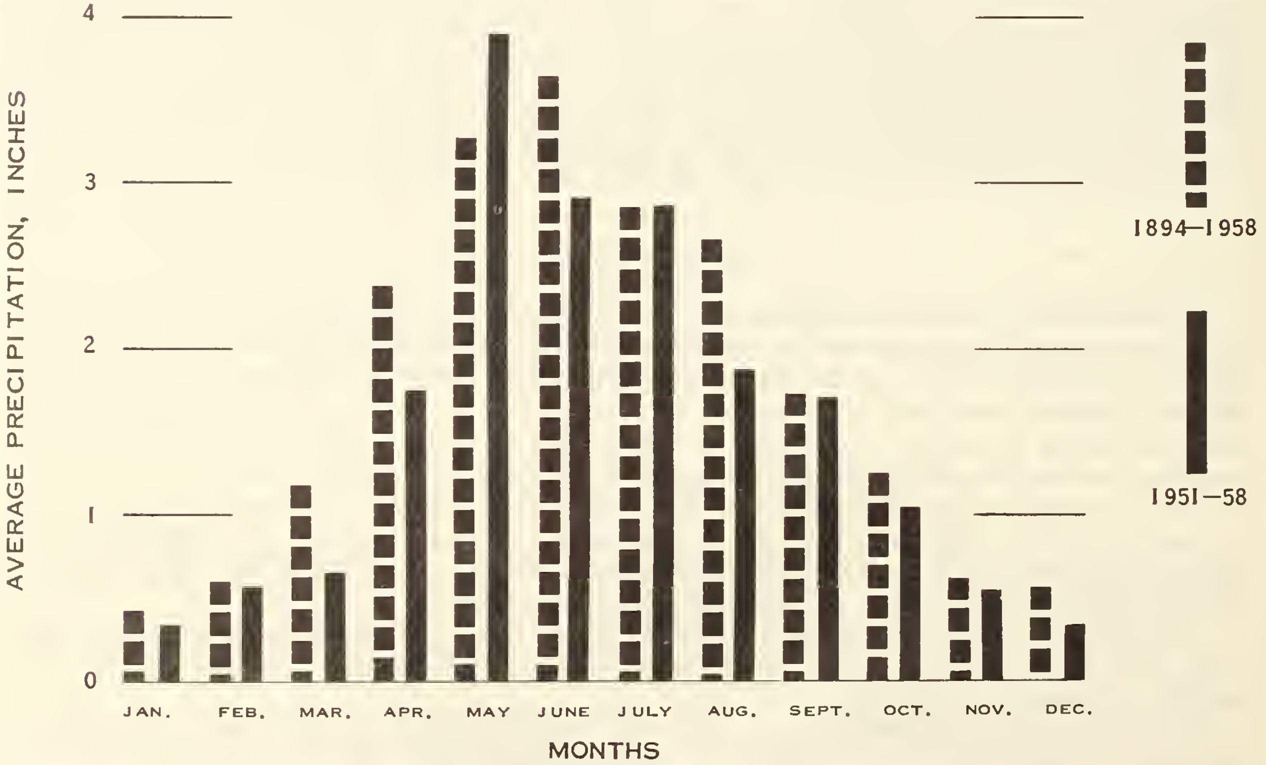


Figure 5.--Distribution of average precipitation for Curtis, Nebr.

When the 1951-58 rainfall was used in the annual precipitation-frequency study (fig. 6), the estimated amount for each percentage chance was less than those calculated from the 1894 to 1958 data. This again points to subnormal rainfall within the 1951-58 interval, and it also indicates that runoff and sediment data for the period may not be representative of the long term.

With the emphasis on predicting the long-term runoff and sediment yields, the annual amounts for runoff and sediment were plotted against precipitation. For the ephemeral stream, Dry Creek, the annual precipitation-runoff and precipitation-sediment relationships plotted on semilogarithmic paper (fig. 7) show a trend.

If it is assumed that the first half-inch of each rain infiltrated into the soil and did not produce runoff and cause erosion, then the abscissa would be accumulated annual rainfall for daily amounts exceeding one-half inch. The graphical fit is improved by this new abscissa (fig. 8). One conclusion to be drawn from figures 7 and 8 is that the relationship of annual precipitation to annual runoff and sediment yields is improved by using only the precipitation amounts greater than one-half inch per day.

Runoff

The runoff for the basin can be characterized in various ways, depending upon whether it is to be used for predicting the flood crest, runoff yield, or sediment yield. The daily flow duration and annual series methods were used in this study, for adjusting the data to long-time conditions on the basis of other long-term records of runoff and precipitation. We used the Cambridge, Nebr., station for the runoff, the Curtis, Nebr., station for the precipitation, and both stations for sediment yield.

Daily Flow-Duration Curves

Daily flow-duration curves were compiled and plotted for each of the six gaging stations on Medicine Creek above Harry Strunk Lake (fig. 1) and for the station near Cambridge for which runoff was collected from 1938 through 1948. A flow-duration curve (fig. 9) indicates the percentage of time within a given period that a discharge is equal to or less than a given rate of flow. These curves based on a short-term record are unreliable for predicting the future pattern of flow. However, Mitchell (12) and Searcy (13) have described an index-station method for adjusting short-term records to represent the long-term conditions. Their procedures were used in correlating runoff during concurrent periods for each gaged tributary with the long-term Medicine Creek records near Cambridge. This was used as a basis for making necessary adjustments to our short-term records. These adjustments were supported by the finding reported in the precipitation section, which shows that 1951-58 rainfall was below normal.

The Cambridge runoff data not only provide a longer record but also a more representative period for climatological conditions. However, there is a changed condition that limits the comparative value of the Cambridge record. The discharge at this station was controlled after 1948 because of storage created upstream by construction of Harry Strunk Lake. This control required an adjustment of the records to simulate unregulated flow conditions after 1948 at Cambridge. This adjustment was made by using the records of inflow into Harry Strunk Lake.

The development of flow-duration curves for long-term estimates required projected discharges that would occur as infrequently as once in 20 years. These discharges were calculated from a logarithmic normal probability analysis of the largest annual daily flows.

The 1951-58 curves on figures 9 through 14 have higher flows than those for 1952-58 because of high rainfall and runoff in 1951. When these two intervals were correlated with identical periods at the Cambridge station and adjusted by the station-index method (13) to the long-term record (1938-58), the 1951-58 adjusted curves were not always higher than the 1952-58 adjusted curves. The adjusted flow-duration curves have considerably higher discharges for a portion of the curves than the nonadjusted curves.

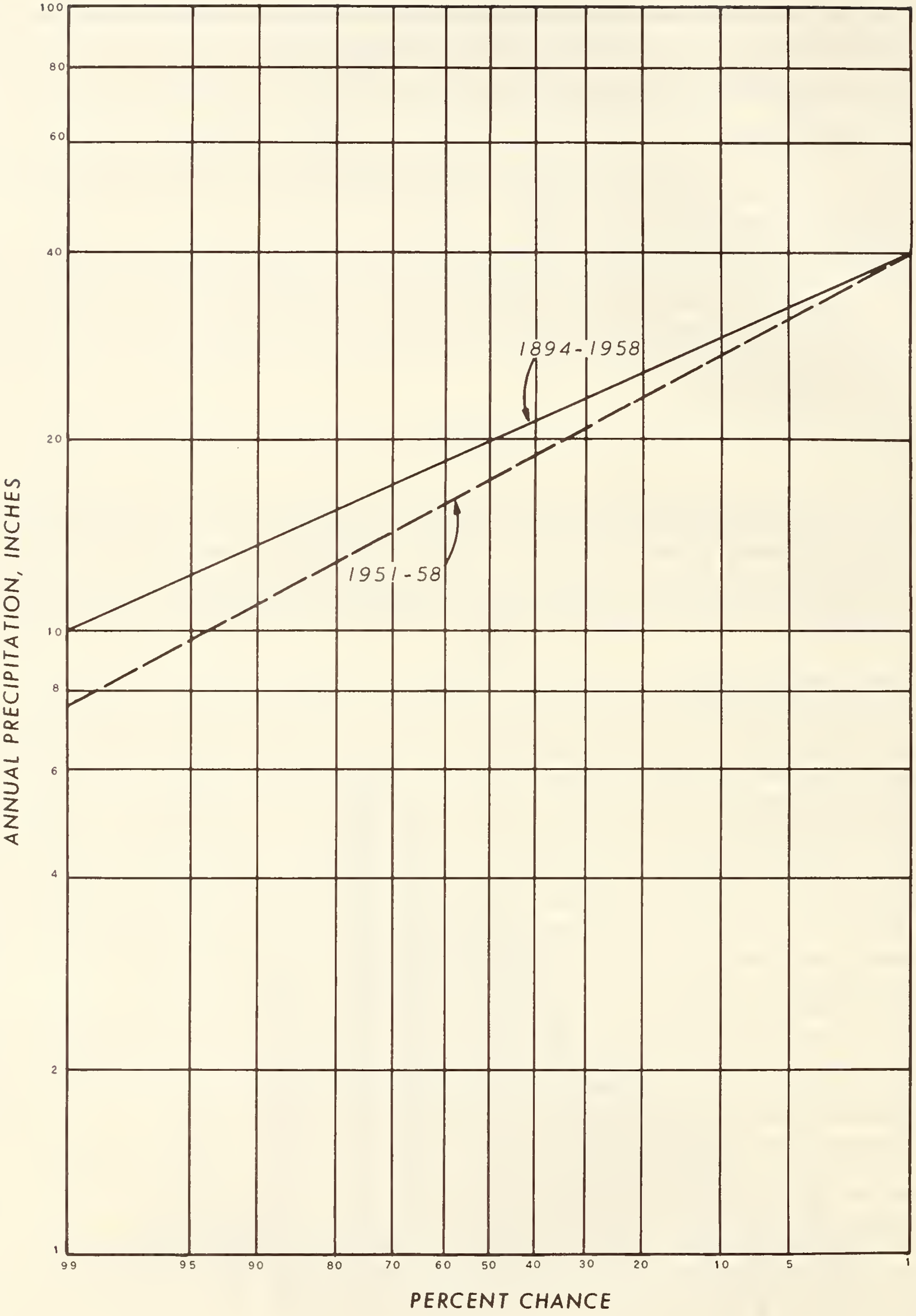


Figure 6.--Precipitation-frequency curves, annual series, Curtis, Nebr.

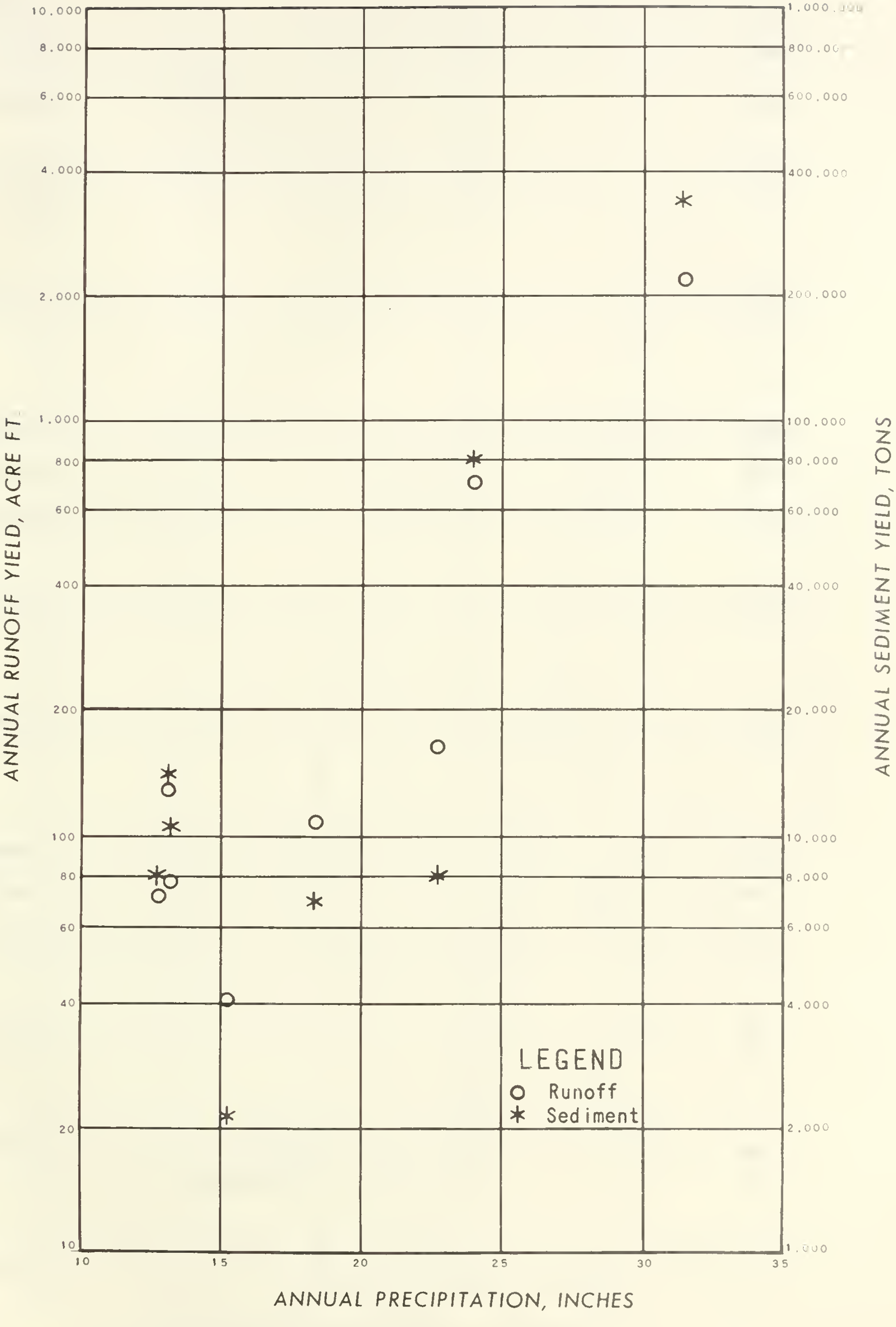


Figure 7.--Relationship of annual precipitation to annual runoff and annual sediment yields, Dry Creek, Nebr.

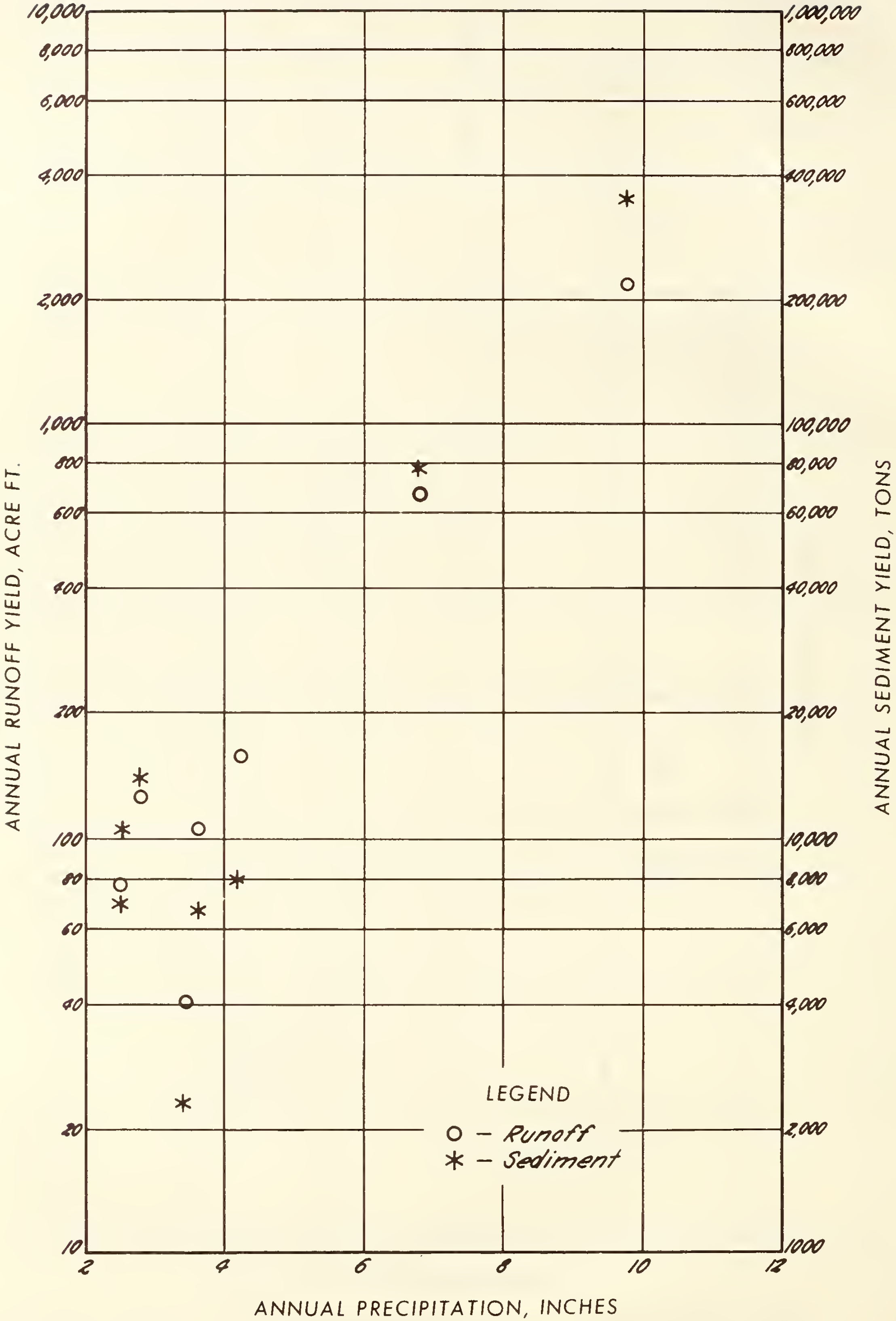


Figure 8.--Relationship of annual precipitation (for amounts greater than one-half inch per day) to annual runoff and annual sediment yields, Dry Creek, Nebr.

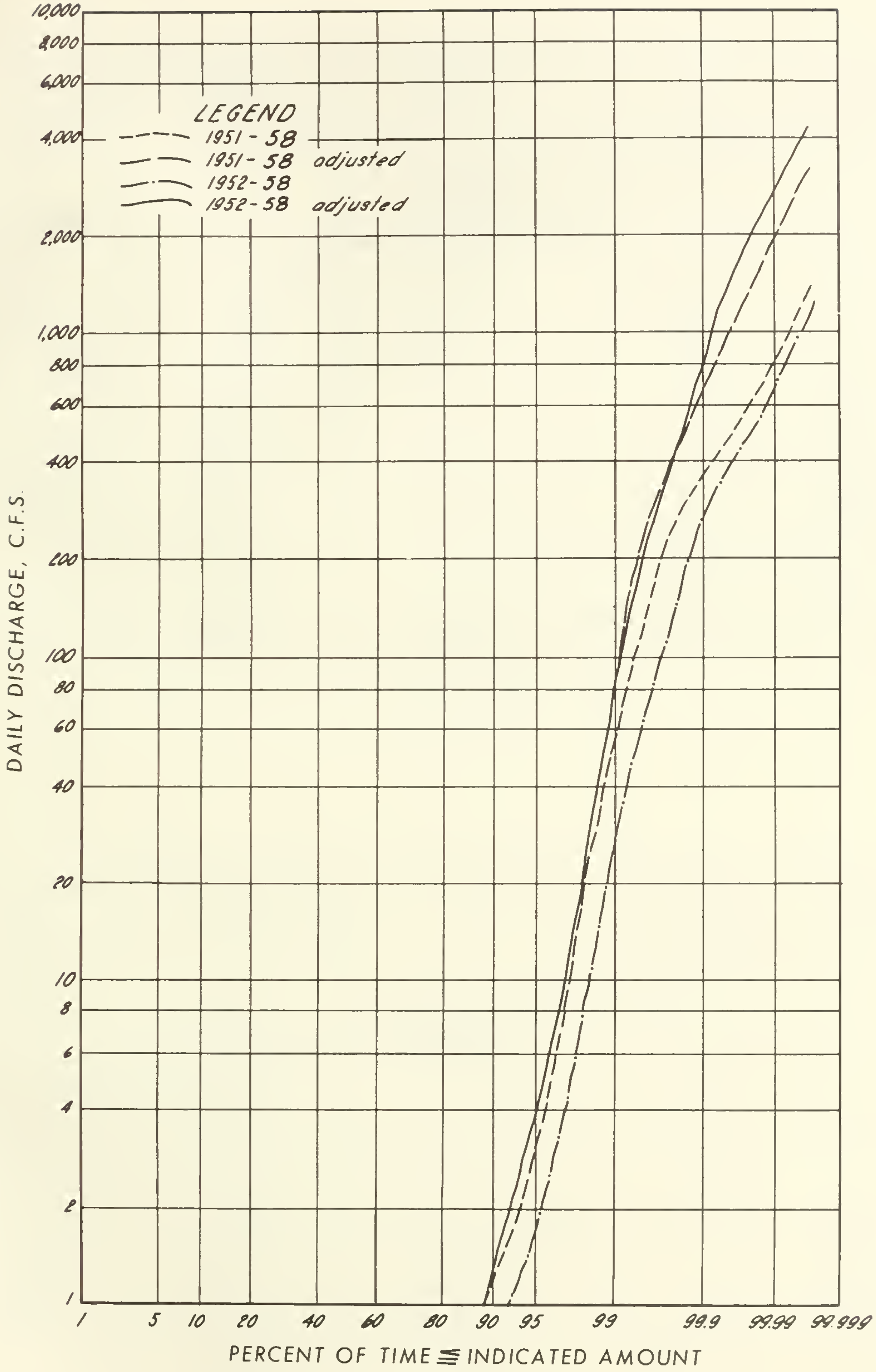


Figure 9.--Flow-duration curves for Brushy Creek, Nebr.

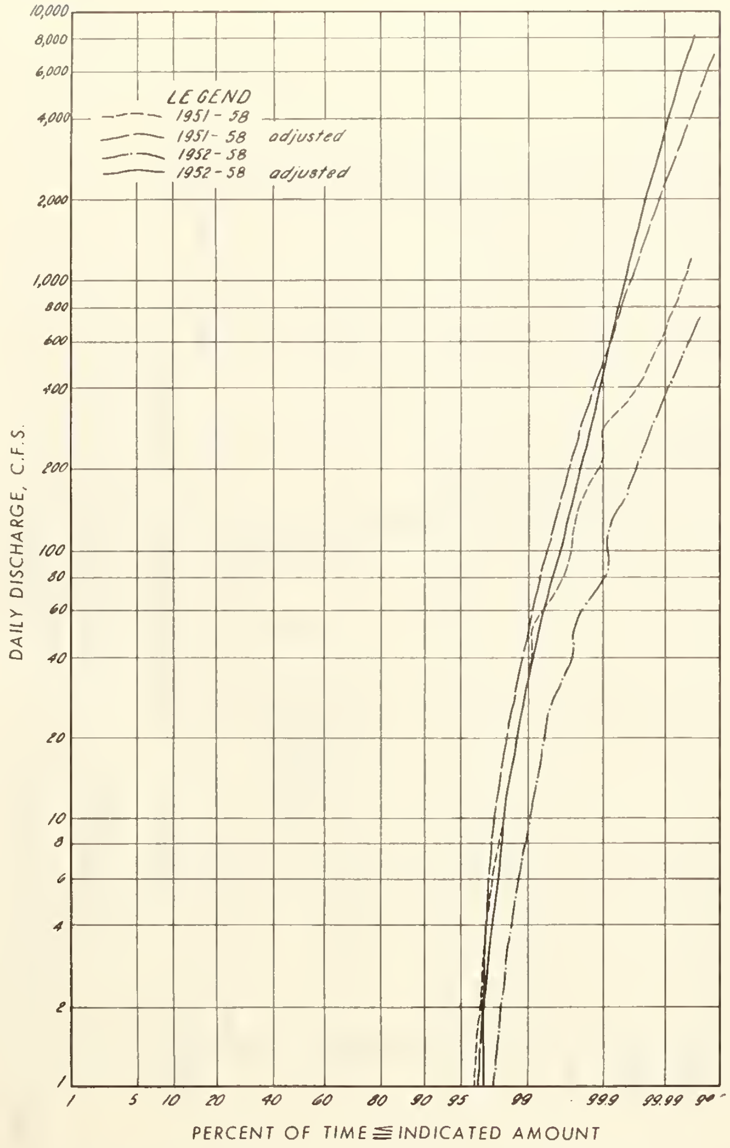


Figure 10.--Flow-duration curves for Dry Creek, Nebr.

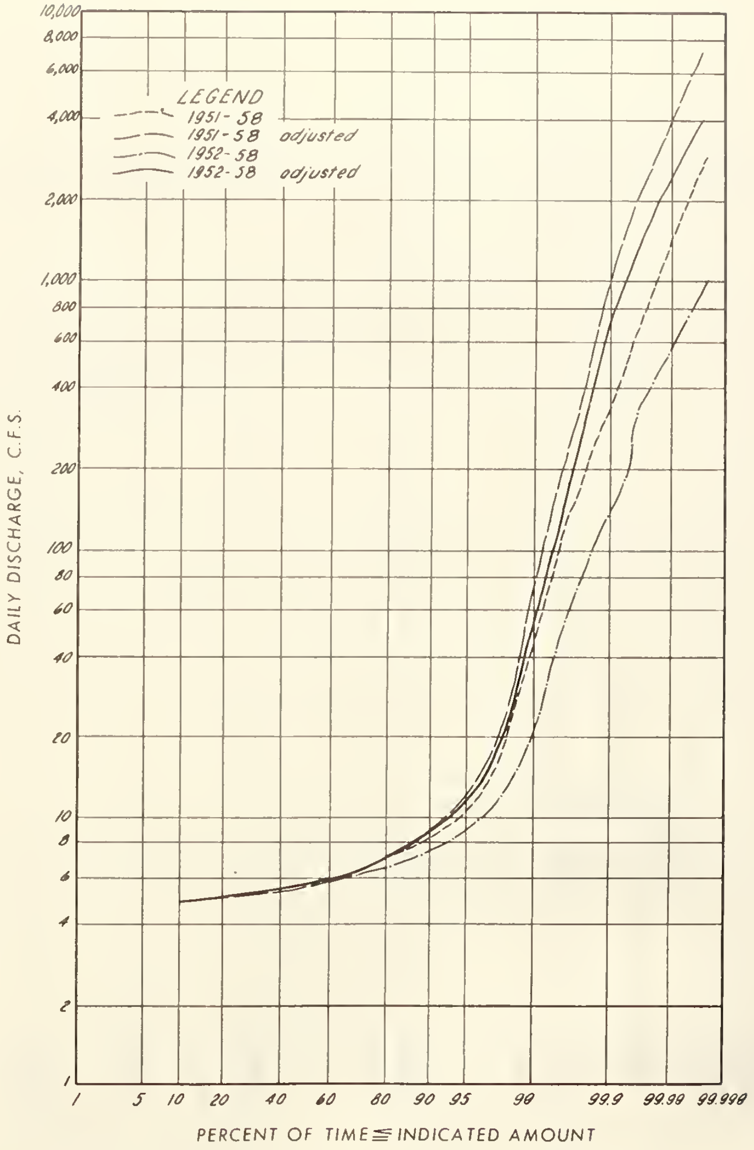


Figure 11.--Flow-duration curves for Fox Creek, Nebr.

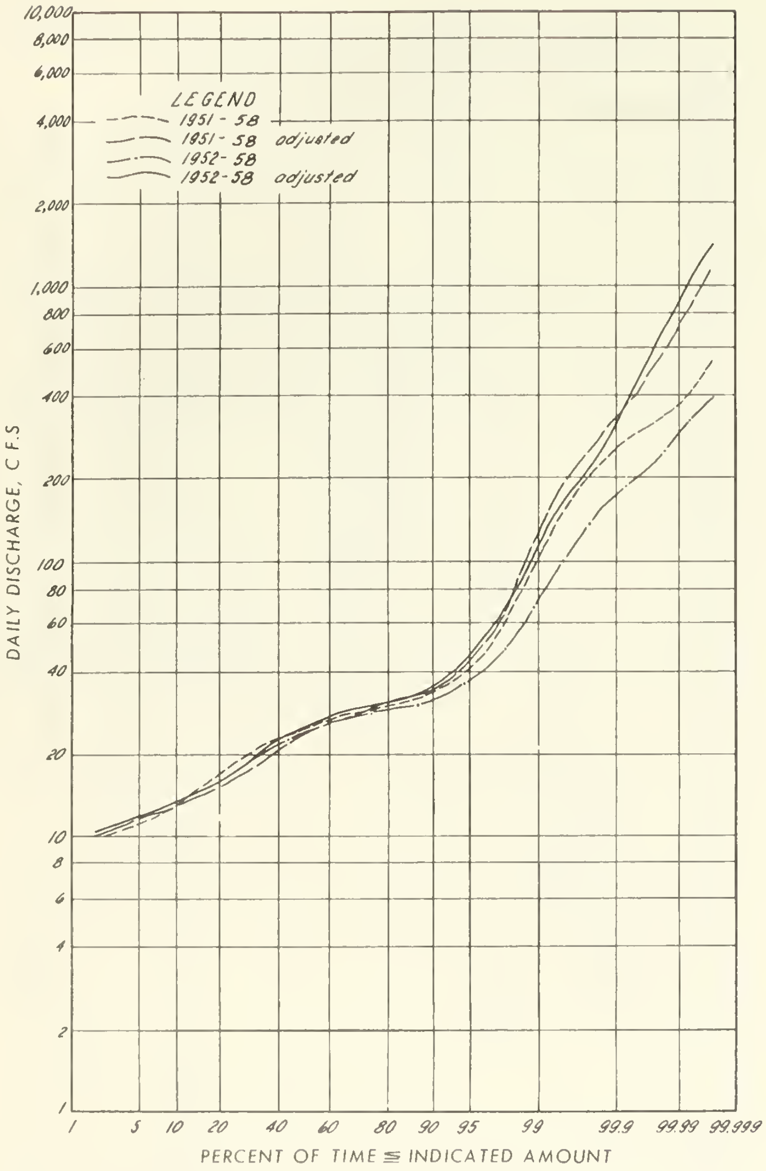


Figure 12.--Flow-duration curves for Medicine Creek at Maywood.

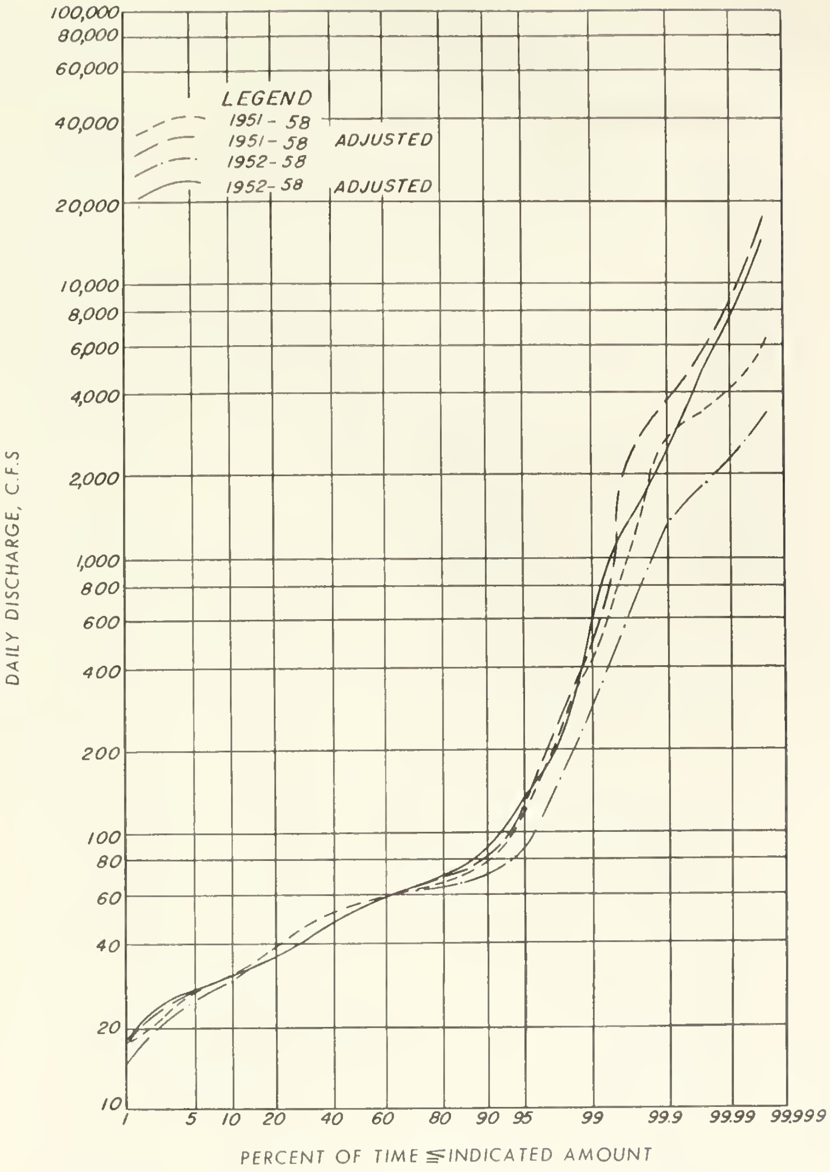


Figure 13.--Flow-duration curves for Medicine Creek above Harry Strunk Lake.

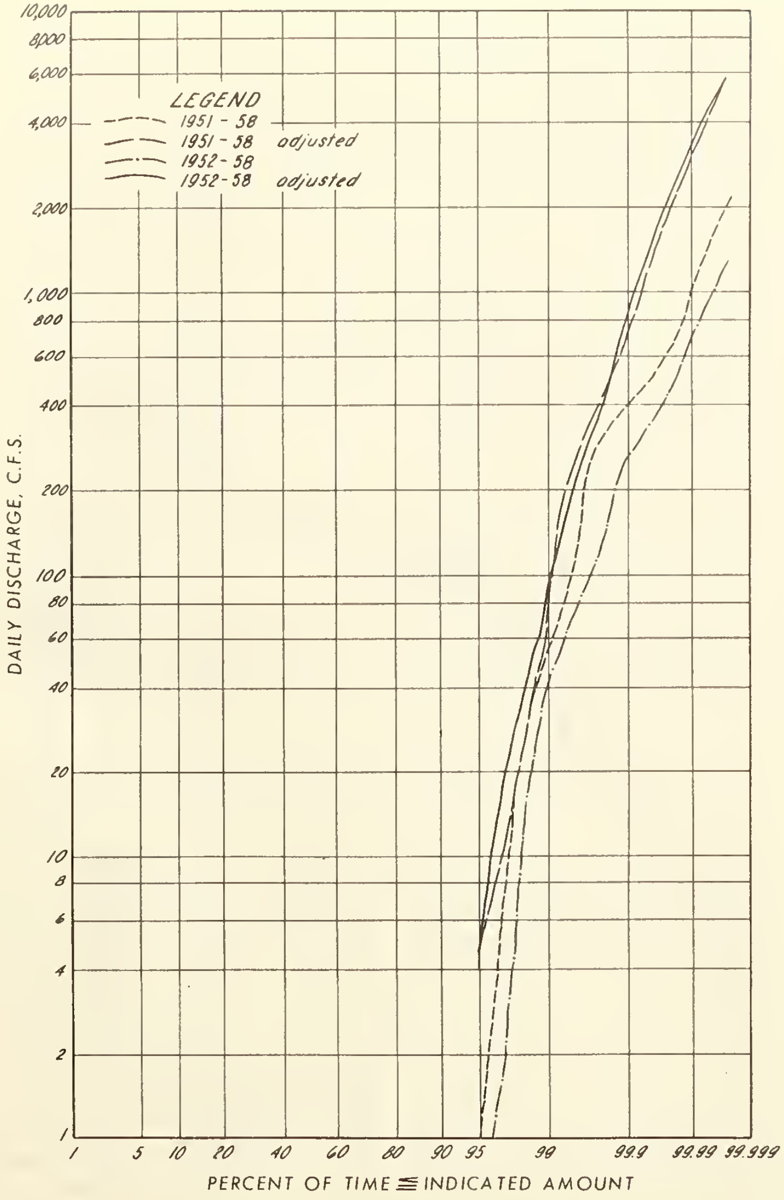


Figure 14.--Flow-duration curves for Mitchell Creek, Nebr.

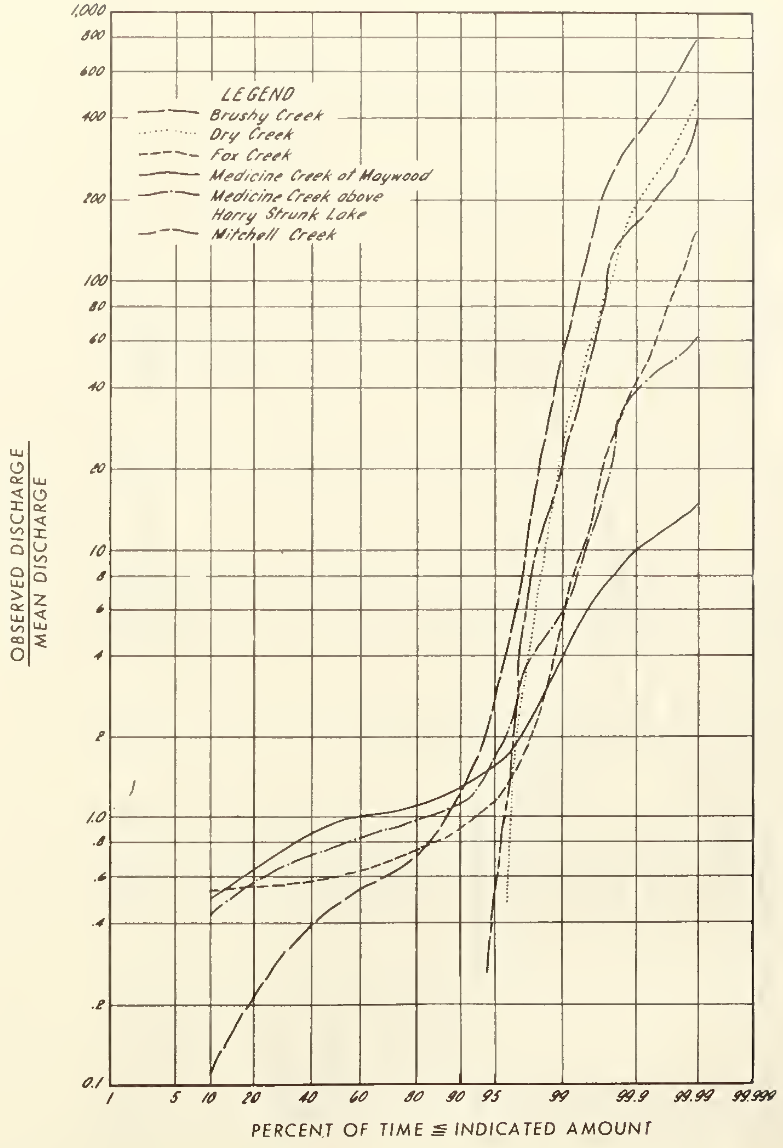


Figure 15.--Dimensionless flow-duration curves, 1951-58.

Dimensionless plots were made for each station by dividing the observed runoff discharges by the 8-year mean discharge. For comparison of flow-duration curves between the six gaging stations, these plottings are shown on figure 15.

The dimensionless flow-duration curves are not identical, but when separated into three flow categories they appear to form groups. Fox Creek and Medicine Creek stations are perennial streams, Brushy Creek is an intermittent stream, and Dry Creek and Mitchell Creek are ephemeral streams. Other factors that may have an influence on dimensionless flow-duration curves are ground water and the interrelationship of drainage area and basin length.

Medicine Creek at the Maywood station is a perennial stream with a large base-flow component. Because of this, the daily runoff from infrequent large-rainfall storms at the 99.9-percent time level (fig. 15) was only 10 times higher than the mean of the 8-year period. The ratio of runoff from the infrequent large-rainfall storms at the 99.9-percent time level to the mean runoff for storms from other watersheds would be much higher. The magnitude of the runoff ratios appears related to drainage area, except for Brushy Creek and Medicine Creek at Maywood. The large base-flow component of Medicine Creek at Maywood and the relatively low length-area relationship of Brushy Creek (fig. 16) may account for their divergence.

The storm runoff portion for each flow-duration curve is distinguished by the steep slope shown on figure 15. If a straight line were drawn tangentially to the lower part of the steep slope of each curve, it would intersect the abscissa at about 90 percent of the time for all these stations.

The long-term runoff yields were computed for all major stations, as shown in table 5. The values shown in column 4 of table 5 for Medicine Creek above Harry Strunk Lake were read from flow-duration curves (fig. 13) using as the ordinates the values in column 3. Values in column 4 were multiplied by percentage time intervals in column 2 to calculate runoff (column 6). Summations of column 6, converted to acre-feet, are the average annual runoff yields for the watersheds. Table 5 also contains an example of computations of average annual sediment yield.

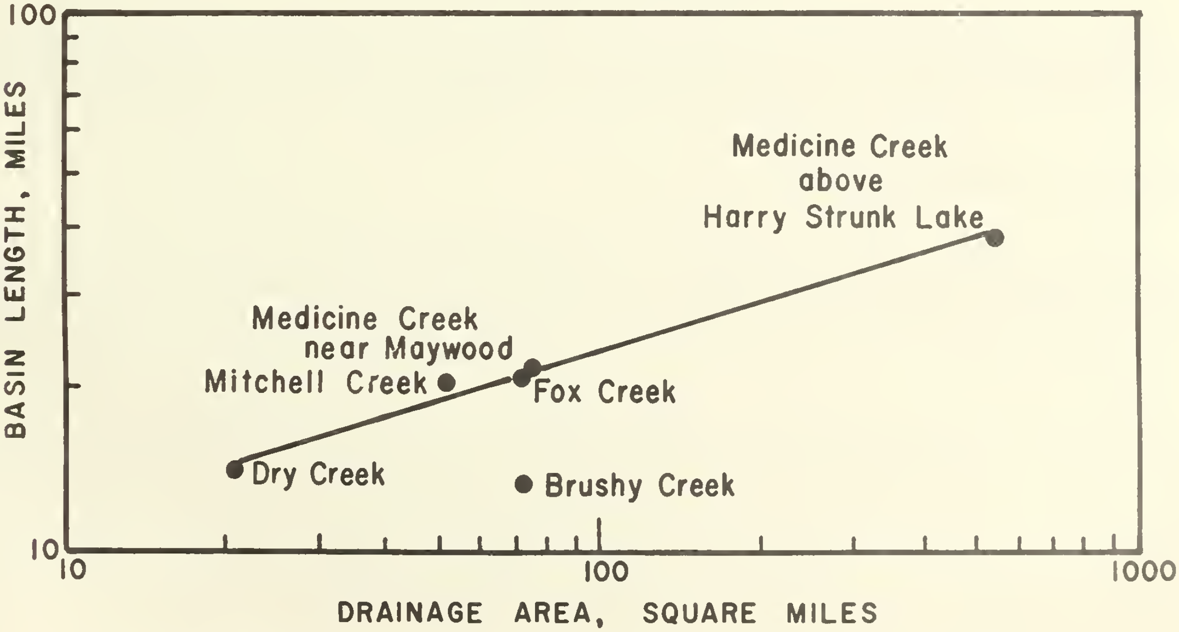


Figure 16.--Relationship of drainage area to basin length, Medicine Creek Watershed, Nebr.

Annual Series

If the runoff data are assumed to be representative and adequate for the long-term climatic condition, a frequency-probability approach could be used to predict the average annual runoff and sediment yields for the long term.

Annual runoff quantities generally fit a logarithmic normal distribution; therefore, a statistical approach was used for computing frequencies for comparative purposes. The data were also plotted on logarithmic normal graph paper, which permitted inspection of the fit of the data to the computed curve. From the graphical frequency distribution (fig. 17 and 18), a tabular annual runoff list was prepared for the 10 highest years expected in one hundred years and the means for each 10-year period of the remaining 90 years, which were later multiplied by ten (table 6).

Because the average annual precipitation for the period 1951-58 was less than the mean for the long-term record, some adjustment was necessary to make it representative of a long-term period. Annual precipitation and runoff for equal probabilities were correlated for the 1951-58 interval. The runoff yield was estimated for a longer period from a precipitation frequency determination for 1894-1958 data and the runoff-precipitation correlation for 1951-58. These runoff values (table 6) are also shown graphically on figures 19 and 20.

Summary of Runoff Discharge and Yields

The adjusted runoff discharges, one by precipitation and the other by longer runoff records, were higher than the discharges actually observed in the 1951-58 interval (table 7). The greatest runoff adjustments from the flow-duration method, had differences of as much as 100 percent. By the frequency-of-flow method, the ephemeral streams have the greatest increase, while the perennial streams--such as Medicine Creek at Maywood and above Harry Strunk Lake--have only very small increases.

Sediment-Rating Curves

The sediment-rating curves and runoff curves are used to compute sediment yields. The sediment-rating curves were determined from concurrent values of the daily and annual runoff and sediment discharge values for each of the six stations.

Daily Sediment-Rating Curves

Curves used to compute the correct sediment yields for a 1951-58 period were derived by stratifying daily runoff values according to the flow rates and finding an average for each group. The average sediment discharge for each runoff grouping was derived from the associated concordant sediment values. From these averaged runoff and sediment values, the rating curves were drawn.

Because of the large difference in precipitation and runoff between 1951 and the other years (1952-58), the sedimentation data were plotted separately for these two periods (figs. 21 through 26). For Fox Creek and Medicine Creek above Harry Strunk Lake, the 1951 sediment discharges are 5 to 10 times higher for equal runoff discharges for high flows than in the other years of record. The instantaneous sediment discharges (triangular symbols in figs. 21 to 26) have lower values for an equal runoff discharge than the daily values for Brushy Creek, Dry Creek, Mitchell Creek, and Medicine Creek above Harry Strunk Lake. The instantaneous data fit among the daily values for Fox Creek and Medicine Creek near Maywood.

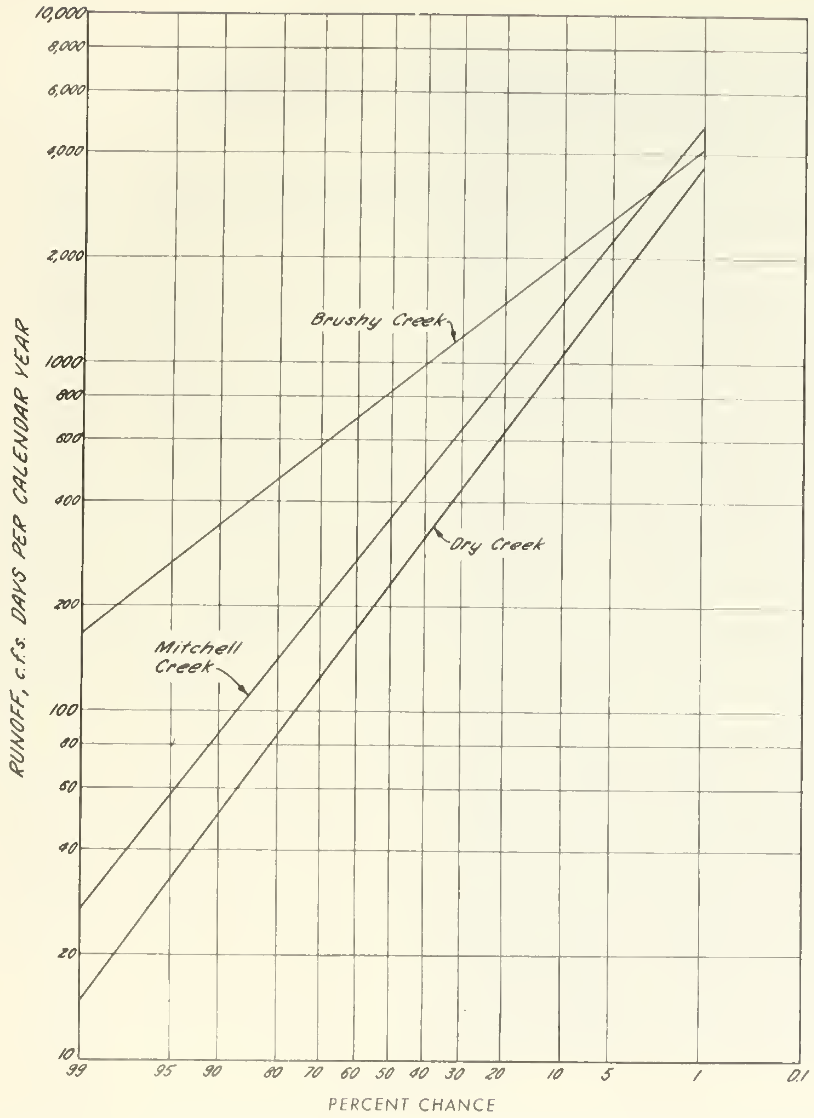


Figure 17.--Runoff-frequency curves for Brushy, Mitchell, and Dry Creeks, Nebr., annual series, 1951-58.

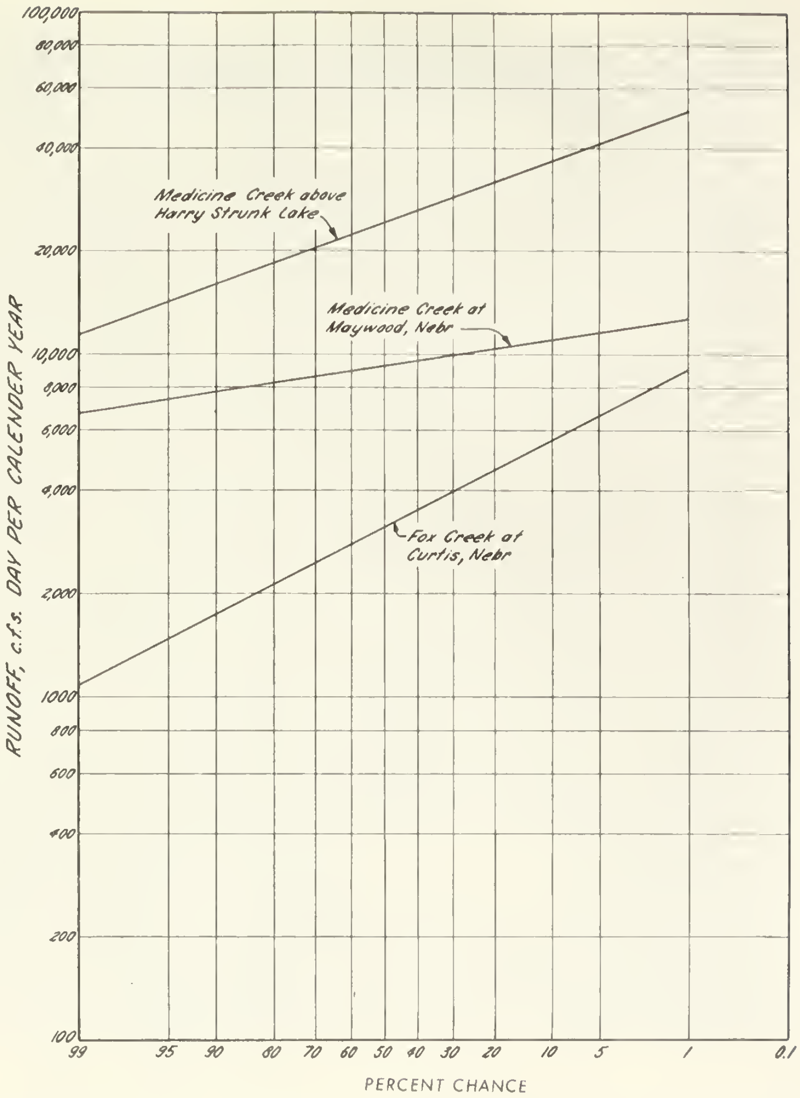


Figure 18.--Runoff-frequency curves for Medicine Creek above Harry Strunk Lake, Medicine Creek at Maywood, and Fox Creek at Curtis, Nebr., annual series, 1951-58.

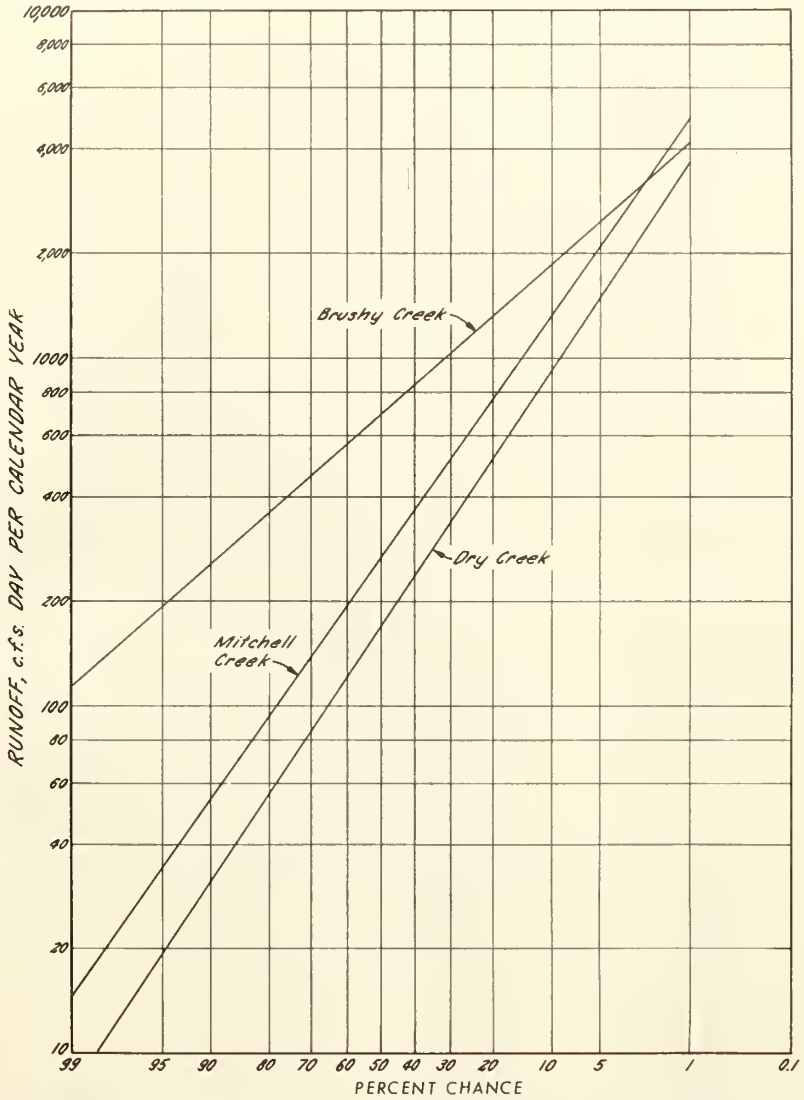


Figure 19.--Runoff-frequency curves adjusted for precipitation for Brushy, Mitchell, and Dry Creeks, annual series.

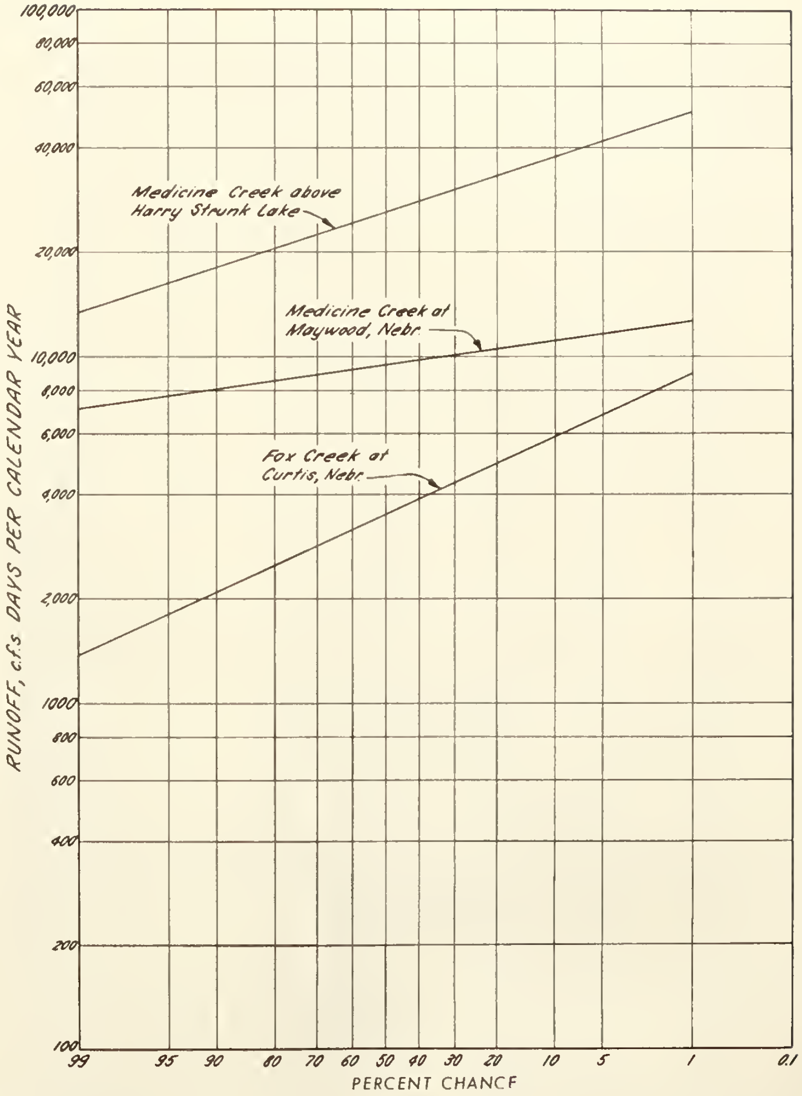


Figure 20.--Runoff-frequency curves adjusted for precipitation for Medicine Creek above Harry Strunk Lake, Medicine Creek at Maywood, Nebr., and Fox Creek at Curtis, Nebr., annual series.

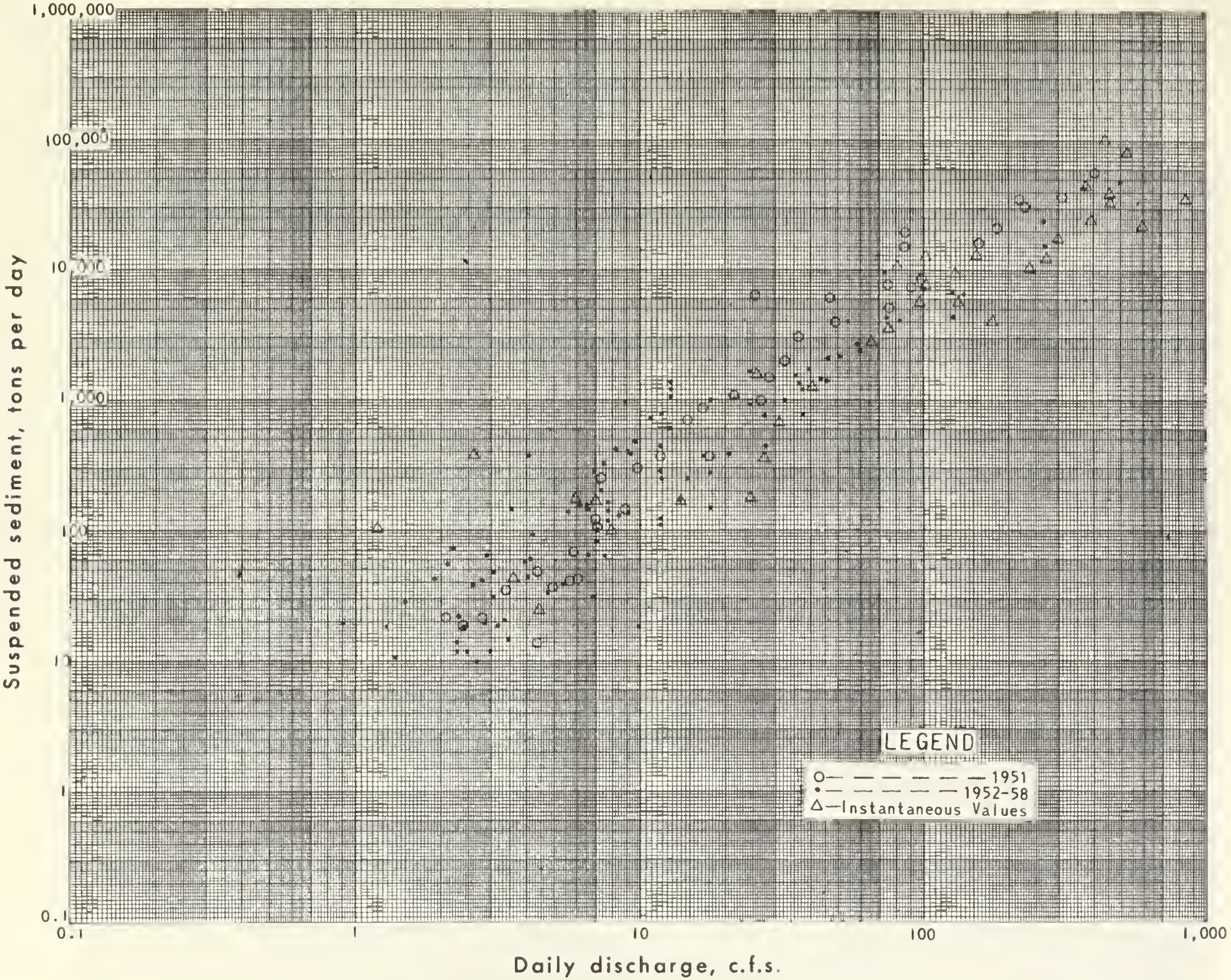


Figure 21.—Daily sediment-rating curve for Brushy Creek, Nebr., for 1951-58 water years. Sediment discharge less than 10 tons per day is not shown.

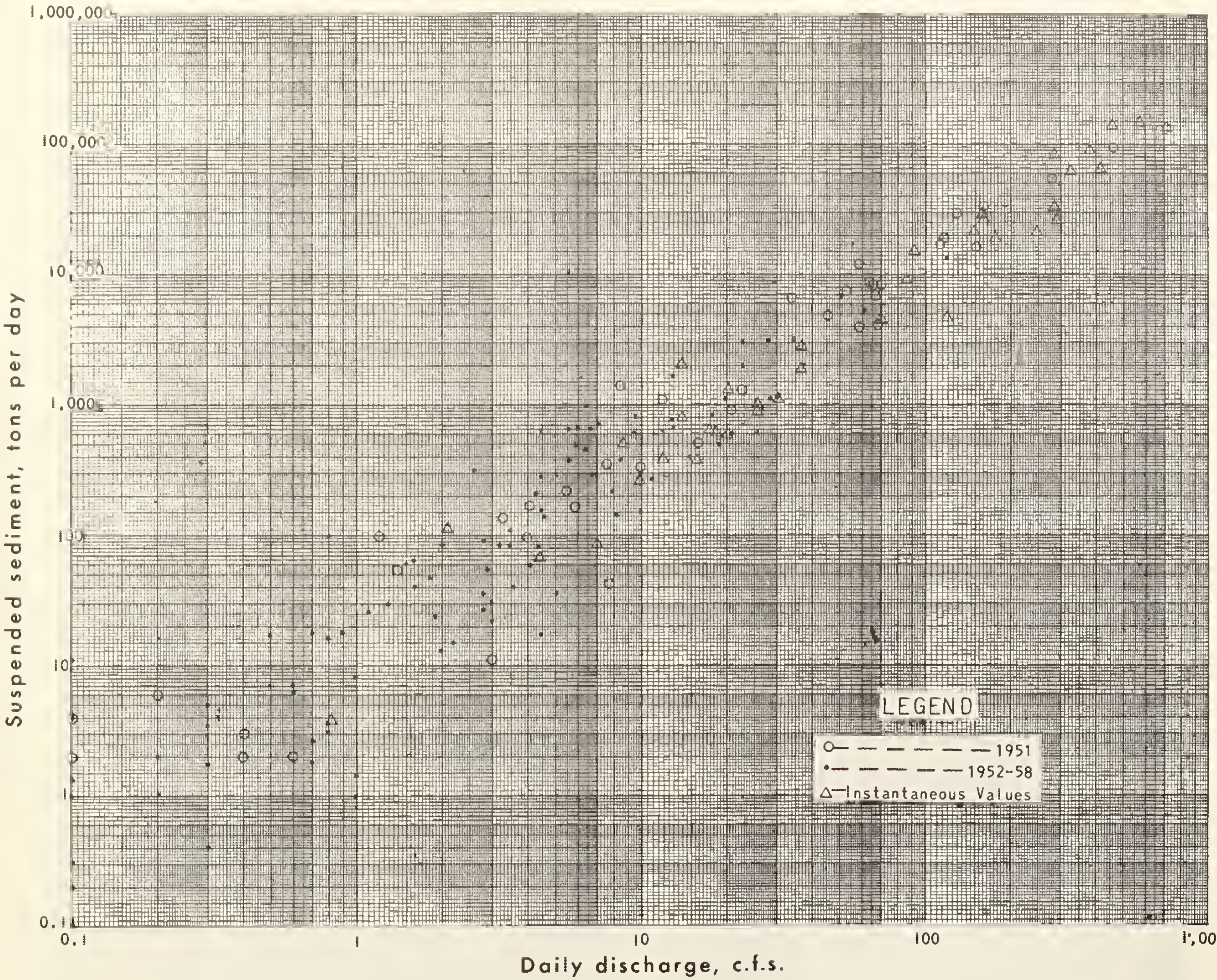


Figure 22.--Daily sediment-rating curve for Dry Creek, Nebr., for 1951-58 water years.

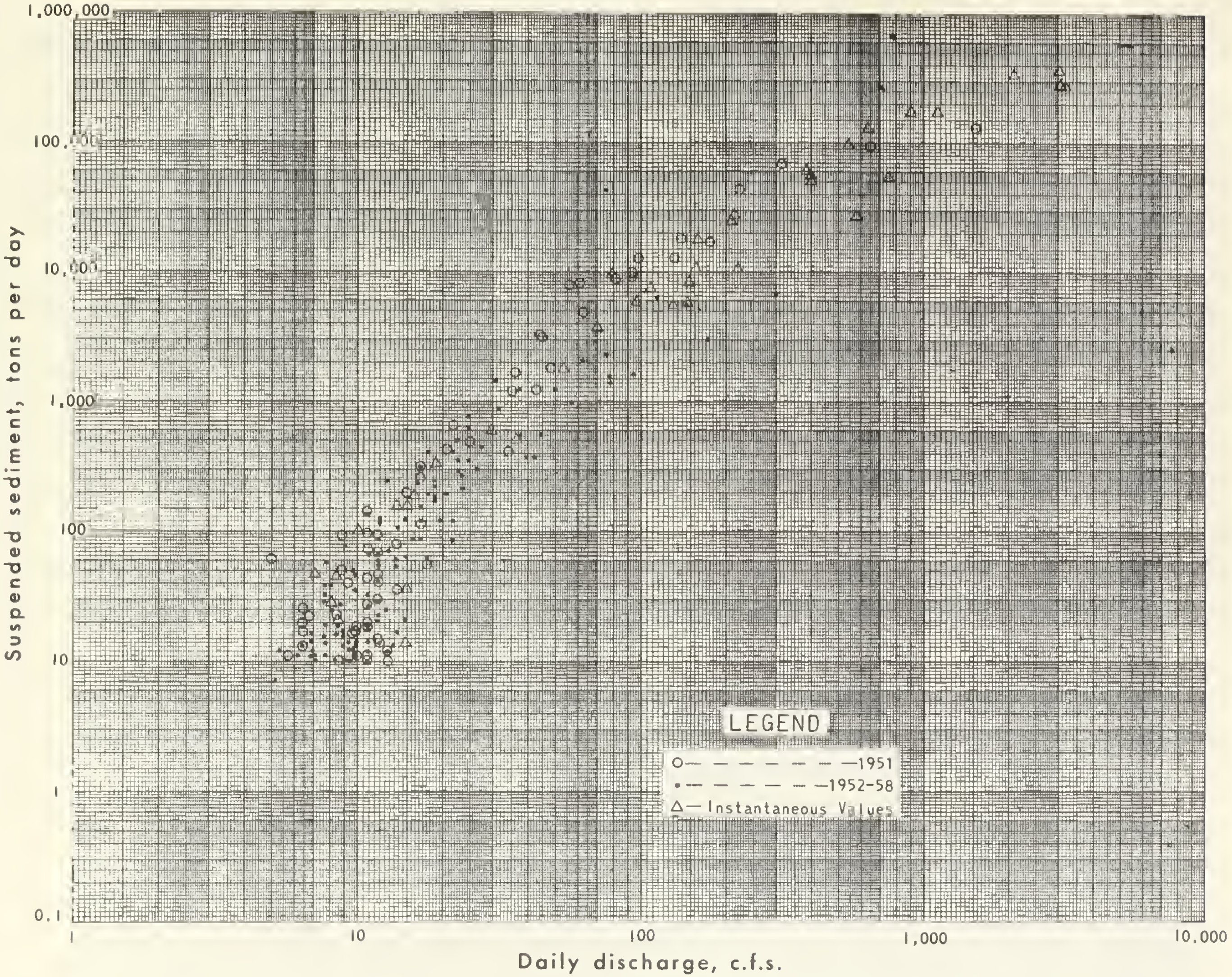


Figure 23.—Daily sediment-rating curve for Fox Creek, Nebr., for 1951-58 water years. Sediment discharge less than 10 tons per day is not shown.

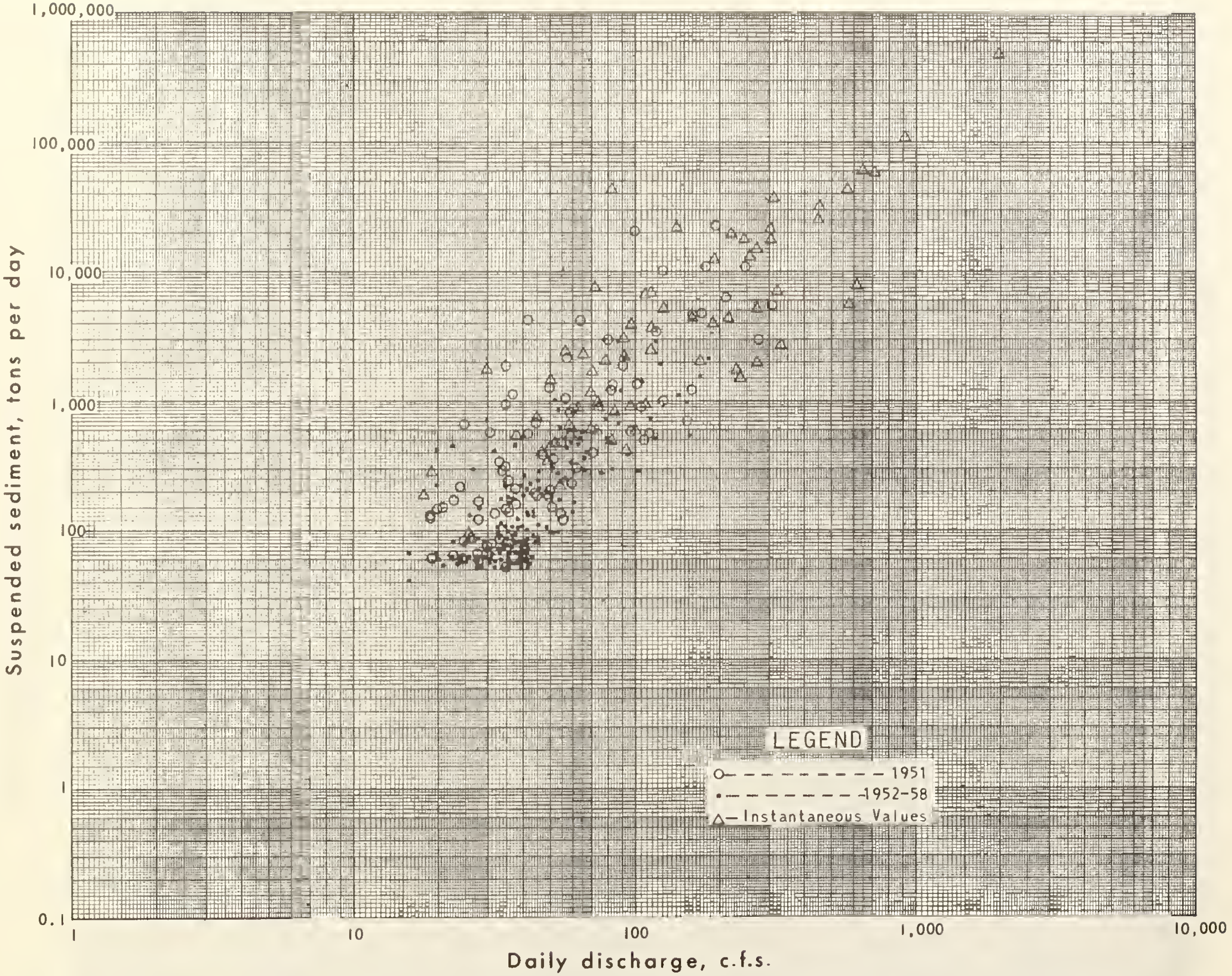


Figure 24.--Daily sediment-rating curve for Medicine Creek at Maywood, for 1951-58 water years. Sediment discharge less than 50 tons per day is not shown.

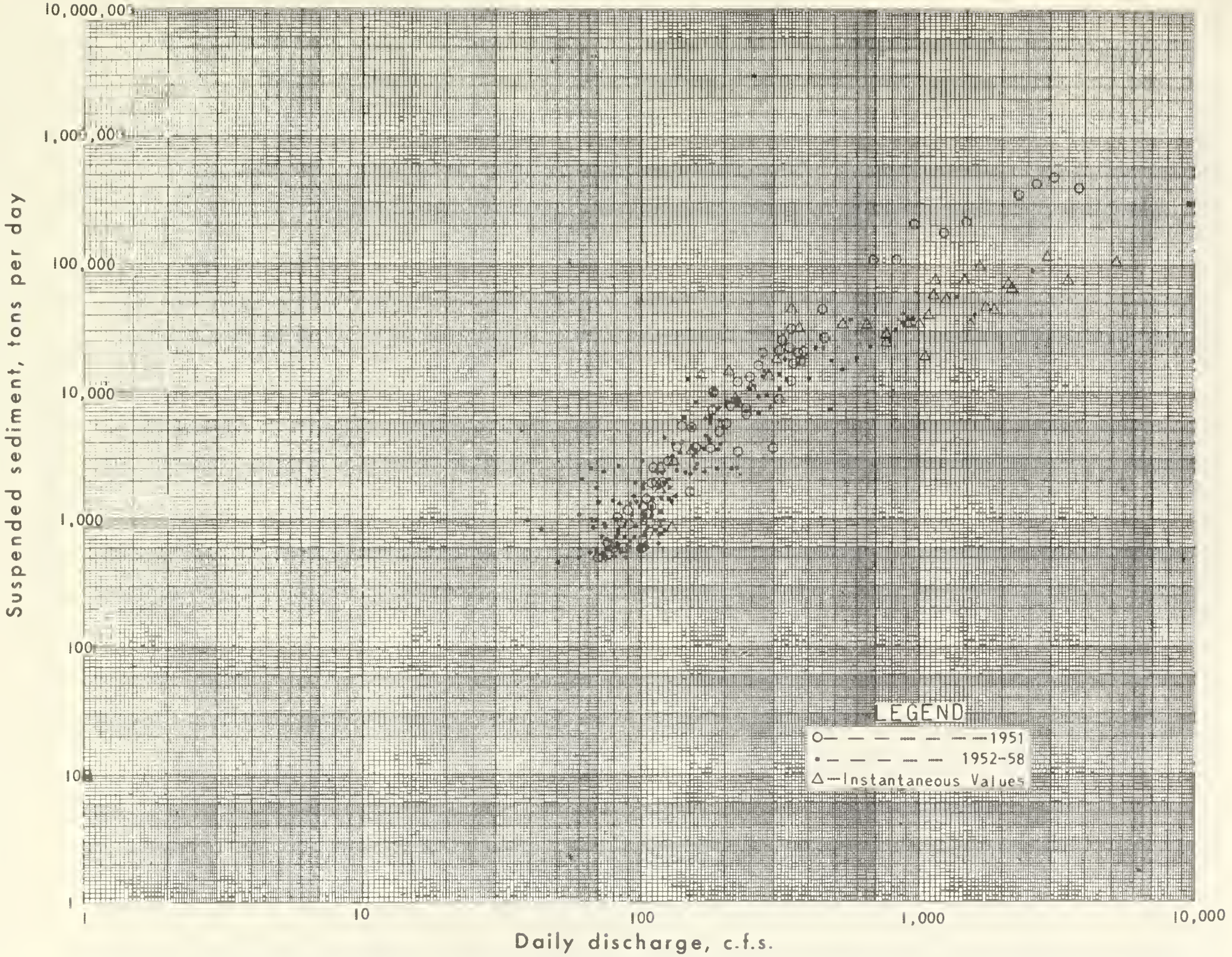


Figure 25.--Daily sediment-rating curve for Medicine Creek above Harry Strunk Lake, for 1951-58 water years. Sediment discharge less than 500 tons per day is not shown.

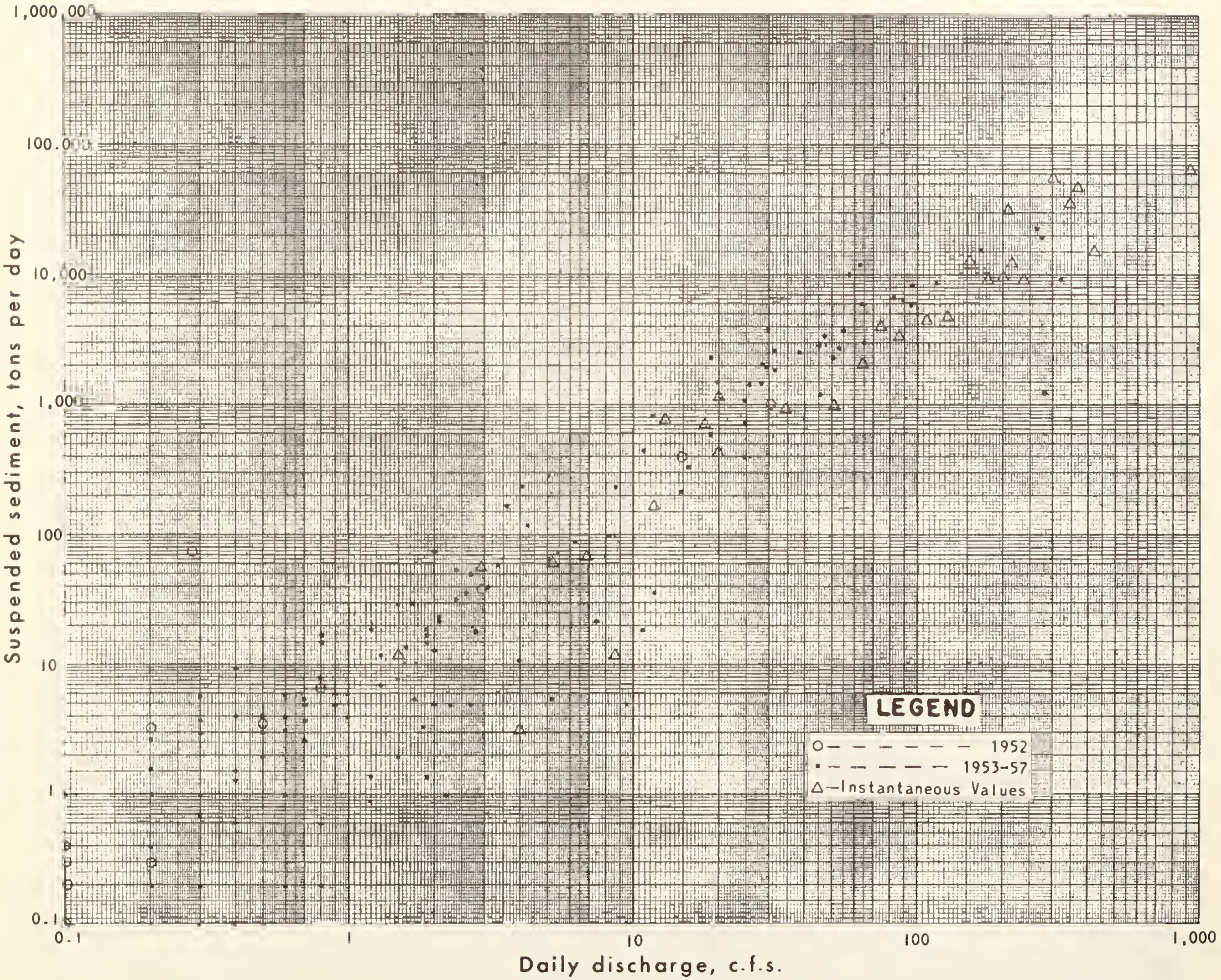


Figure 26.--Daily sediment-rating curve for Mitchell Creek, Nebr., for 1952-58 water years.

When all rating curves are expressed mathematically, the portion with high sediment loads fits the following power equation:

$$S = KQ^n$$

where S = sediment in tons per day

Q = runoff in cubic feet per second per day

n = exponent

K = coefficient

e = base of natural logarithms

For five of six stations the exponents (n) of Q are close together, ranging from 1.32 to 1.44 as follows:

Creeks	Equations
Brushy ----------	$\text{Log}\,(S + 15.3) = 1.119 + 1.382\,\text{Log}\,Q$
Dry ------------	$\text{Log}\,S = 1.411 + 1.348\,\text{Log}\,Q$
Fox ------------	$\text{Log}\,(S + 440) = 1.212 + 1.325\,\text{Log}\,Q$
Medicine -------- Maywood	$\text{Log}\,(S + 32) = -0.642 + 1.883\,\text{Log}\,Q$
Medicine above ---- Harry Strunk Lake	$\text{Log}\,S = 0.547 + 1.44\,\text{Log}\,Q - 2.5e^{-0.0175Q}$
Mitchell ---------	$\text{Log}\,S = 0.997 + 1.438\,\text{Log}\,Q$

Because of the narrow range between the exponent values, the increase in sediment load for an increase in runoff discharge is approximately in the same ratio for each of these streams. While the ratios may be similar between these streams, the actual sediment load and concentration may be very different. Note that the exponent n and ratios are based upon the average of grouped runoff and sediment data and not the individual days, which vary more.

Annual Runoff-Sediment Relationship

The concurrent annual runoff and sediment discharges were plotted to determine their relationship. The perennial and ephemeral streams could again be separated into groups according to the slopes of their curves on logarithmic paper. The perennial streams (fig. 27) have steeper curves and are better related than the ephemeral streams (fig. 28).

Annual Sediment-Rating Discharge per Square Mile

The perennial streams have very steep sediment rating curves (fig. 29), and values are grouped nearer the mean curves than values for the intermittent and ephemeral streams--Brushy, Dry, and Mitchell Creeks.

The runoff and sediment yields per square mile vary as much as a hundred times between different years and between watersheds. Such wide variations between watersheds require ex-

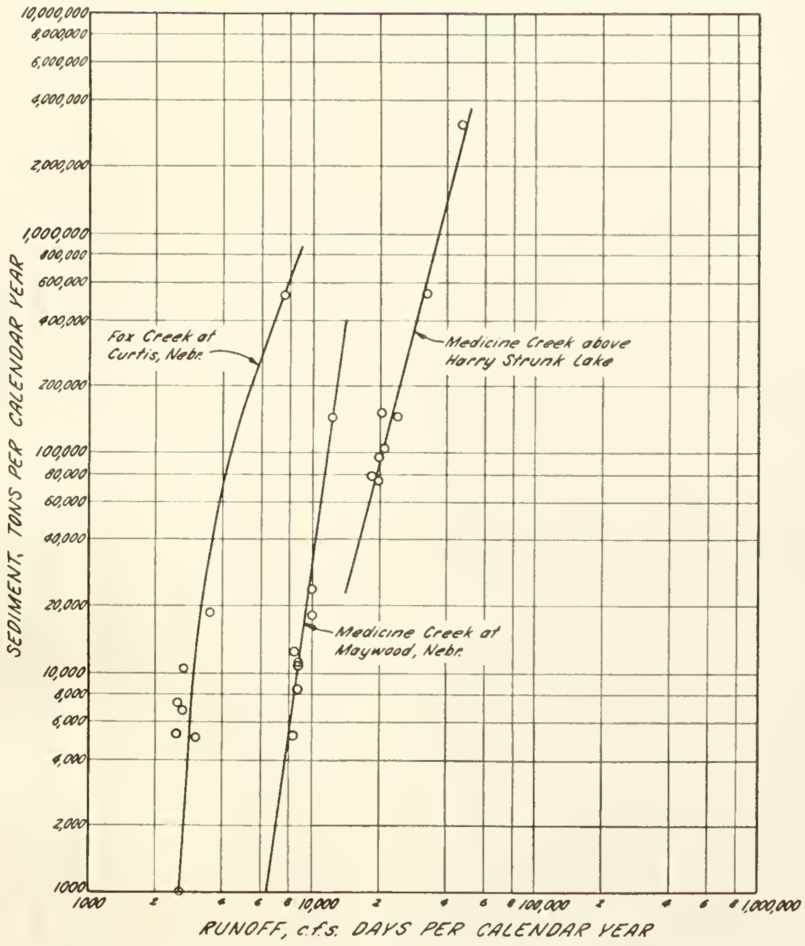


Figure 27.--Annual runoff-sediment relationship for perennial streams, 1951-58.

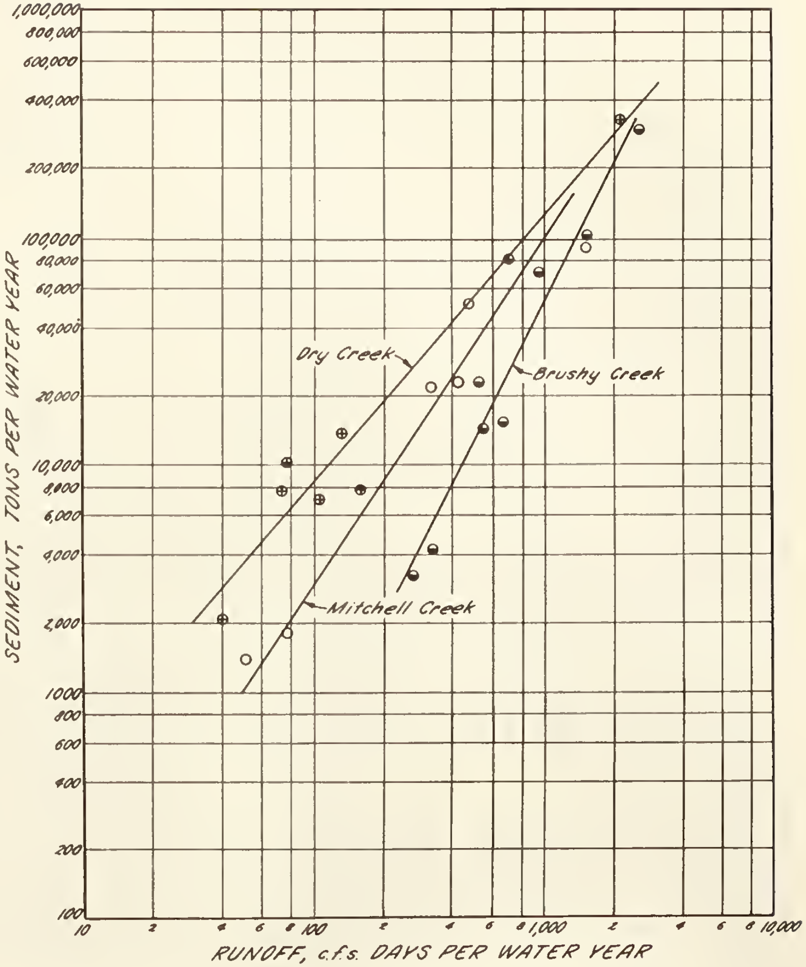


Figure 28.--Annual runoff-sediment relationship for ephemeral streams, 1951-58. In these three creeks the runoff for the water year is nearly identical with the calendar year.

planation before these data can be used properly in other ungaged watersheds. The differences are not resolved in this report, but they might be associated with the channel and gully erosion, the size of uneroded upland flat divides, the distance to ground water from the channel, land use and range management, and many geomorphic characteristics.

Sediment Yield

Two methods--flow duration and annual series--were used to calculate the sediment yields. Frequency of runoff and sediment-rating curves are required for each method.

Flow-Duration Sediment-Rating Curve Method

In the daily flow-duration--daily sediment-rating curve method, flow-duration curves (figs. 9 to 14) for the periods 1951-58 and 1952-58 were used to compare results with and without the wet year of 1951. The yields were also compared with both flow-duration curves after the curves had been adjusted for runoff at the Cambridge station for the period 1938-58 (figs. 9 to 14).

A procedure for making these calculations which was developed by Miller (11) was used in table 5 to select the flow discharges at the mean of a small percentage time interval. The flow-discharge values were used to obtain the sediment load from appropriate sediment-rating curves (fig. 25 for table 5).

The sediment load for each runoff value was multiplied by the percentage of time in the time interval. The average daily yield was determined by summing the intervals, and when multiplied by 365, the average annual sediment yield for the watershed was established. (See table 5 for an example of these computations).

Annual Series Method

In the annual series method, annual runoff and runoff-sediment relationships were used instead of the daily values as in the flow-duration method. The annual runoff from frequency determinations for the 1951-58 water years and the annual runoff adjusted to 1894-1958 precipitation were tabulated. Sediment loads for each of the 10 highest years and for the middle of each of the nine remaining 10-year intervals were determined graphically (fig. 18 for table 6) from runoff-sediment relationships for each runoff discharge. The average annual sediment yields were computed by adding the 10 highest years' yields to the remaining nine 10-year intervals (which were multiplied by tens) and then dividing the total by one hundred (table 6).

Summary of Sediment Yields

Long-term yields determined by the flow-duration sediment-rating curve method (table 8) for 1951-58 were compared with those for 1952-58. The 1951-58 sediment yields and the observed yields were two or more times higher than the yields for 1952-58. The estimated yields were higher than observed, because the flow-duration curves were extended to equal one hundred years by logarithmic probability calculations of the largest annual daily runoffs.

When both 1951-58 and 1952-58 flow-duration curves were adjusted to 1938-58 flows, as described in the runoff section, the long-term sediment yields for 1951-58 and 1952-58 were very close for Dry Creek, Mitchell Creek, and Medicine Creek at Maywood. For Fox Creek and Medicine Creek above Harry Strunk Lake, the 1952-58 adjusted flow-duration curve long-term yields were about two-thirds of the 1951-58 adjusted flow-duration long-term sediment yields. But for Brushy Creek, the 1951-58 adjusted flow-duration yield was two-thirds of the 1952-58 adjusted calculations. For all the stations, the sediment yields were higher for the adjusted flow-duration curves for 1951-58 and 1952-58 whether compared with the unadjusted, observed, or annual series. The largest increase was for Dry Creek, where the 1951-58 adjusted average

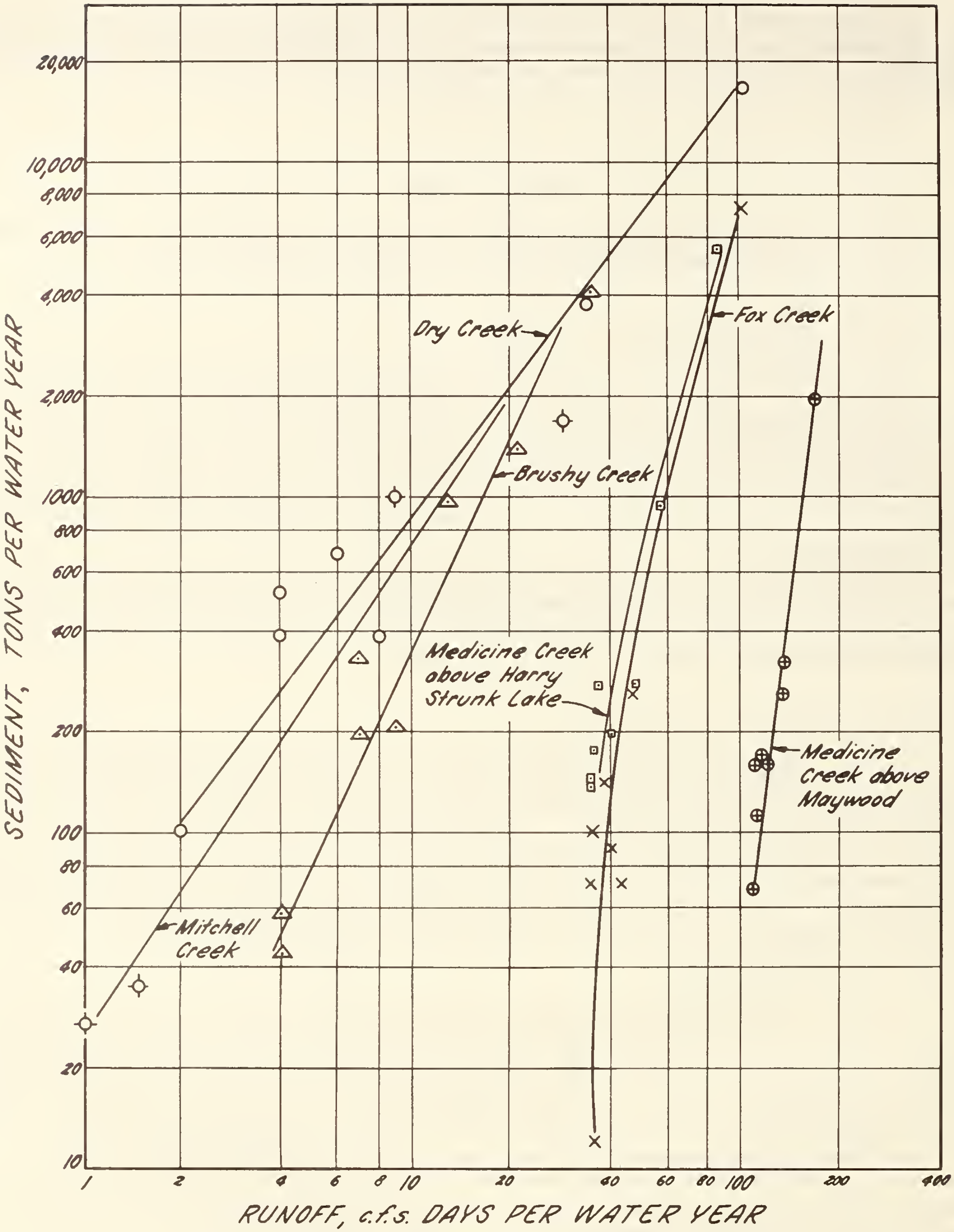


Figure 29.--Runoff and suspended-sediment yields per square mile.

annual yield by the flow-duration sediment-rating curve method was three and one half times higher than the observed. Yield estimates were doubled for Medicine Creek above Harry Strunk Lake.

The observed sediment yields were measured over a short atypical climatological period of time; hence, they should not be expected to be closely related to long-term yields. Whether or not the long-term yield estimates are more accurate and usable, however, cannot be determined because no long-term data are available for checking these estimates.

The unadjusted annual series sediment yields were nearly equal to observed 1951-58 yields, but when annual series were adjusted by long-term annual precipitation, the yields in four of the watersheds increased above the observed yields. These adjusted long-term sediment yields by annual series were much lower than the sediment yields as determined by the adjusted flow-duration sediment-rating curve method (table 8).

The 1951-58 observed sediment yield for Dry Creek was 2,880 tons per square mile per year, which was three times the unit yields for Fox Creek, Brushy Creek and Medicine Creek above Harry Strunk Lake. The Dry Creek yield on a square mile basis from the adjusted 1951-58 flow-duration curve method values is twice that of Mitchell Creek and three times greater than the Fox Creek yield. Both Dry Creek and Mitchell Creek have extensive upland gully activity.

The estimated yields from adjusted flow-duration curves seem very high when they are compared with the observed yields. However, at the Cambridge gage the largest daily water discharge was eight times greater in 1947 than the largest discharge in the 1951-58 interval. High runoff discharge in 1935 probably equaled or exceeded that in 1947. The annual sediment yield would be expected to increase similar to the observed increase from 1952-58 to 1951-58 for such runoff events.

Gully and Channel Erosion

The representatives of the cooperating agencies wanted to determine the importance of gullies and channels as a sediment source. They selected Dry Creek for this study because of the magnitude of the continuous and discontinuous channel development, which is representative of many of the nongaged watersheds.

Several gully and channel reaches (referred to as items in table 9) were monumented and surveyed in 1951 to determine the amount of erosion and to determine if channel erosion was by widening, entrenchment, or both. All of the items were resurveyed in 1952 because of the large amount of erosion during the summer of 1951. In 1956 items 1, 3, and 5 were resurveyed as these were the only ones with any significant changes since 1952. Items 3 and 3a were resurveyed in 1960.

Channel erosion in Dry Creek was computed from engineering field notes for the various items and periods of time. A summary of these computations is shown in table 9. In the interval from May 1951 to May 1952, 111.3 acre-feet of material was eroded from the channel, while 163 acre-feet of suspended sediment was measured at the Dry Creek gaging station (17). These measurements indicate that the channel erosion was equivalent to 68 percent of the measured suspended load. In the next interval, May 1952 to May 1956, 1.28 acre-feet was eroded from channel items 1, 3, and 5, while 14.6 acre-feet of suspended sediment was measured at the Dry Creek gaging station. The 1952-56 channel erosion for these items was equal to 8.8 percent of the measured suspended sediment, while the erosion for these same items during the 1951-52 interval was equal to 22.6 percent of the measured suspended sediment.

The channel erosion for item 3 for 1956-60 cannot be compared to the amount of suspended sediment, but when this channel erosion is compared with erosion from previous time intervals, it indicates renewed erosional activity. Photographs of items 3 and 3A (figs. 30 and 31) show the caving banks and unstable condition which is followed by another active cycle a short distance downstream.

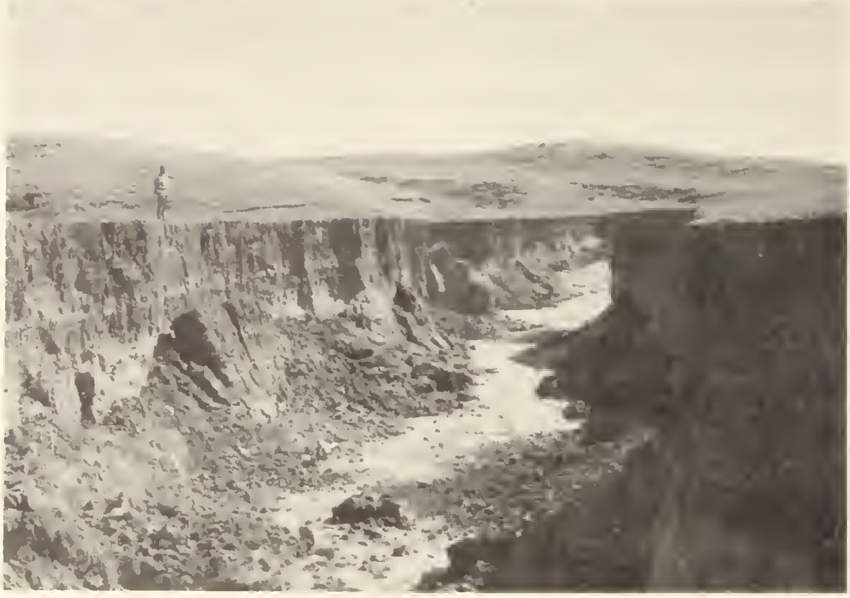


Figure 30.--This photograph, taken May 10, 1960, shows that the channel immediately downstream from the overfall in item 3 is unvegetated and unstable. This channel is 24 feet deep and 60 to 100 feet wide. The overfall has advanced several hundred feet in the past year.

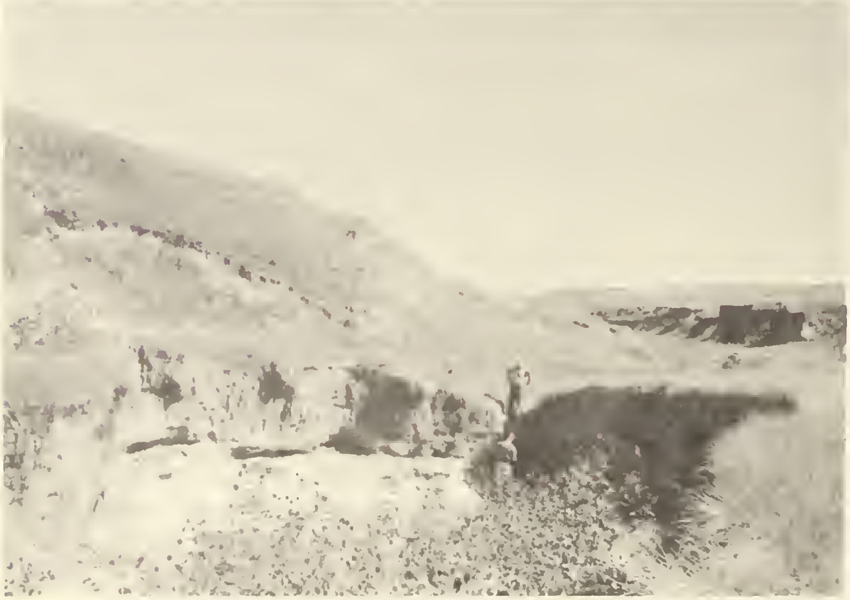


Figure 31.--This photograph, taken September 2, 1960, shows the overfall at item 3A (3,500 feet downstream from item 3). Downstream the channel has entrenched an additional 12 to 15 feet. Upstream the bottom has become stable and is covered with grass. The bank remnant from the channel erosion cycle now active in item 3 (above photo) is shown on the right, upstream.

Figure 32 shows how the channel farther downstream enlarged in 9 years. The area in front of the fence was not grazed at the time either photograph was taken, but grass cover was more abundant at the time of the earlier photograph.

Additional channel erosion data were compiled from aerial photographs taken in 1937, 1952, and 1958. The longitudinal advances of the headcuts and channel widening were easily identified from photographs, but it was not possible to determine the magnitude of degradation. The headcuts in item 1, which is located on the main stem of Dry Creek, and in item 3, which is located on a main tributary, were easiest to see, and thus the data from those items were probably the most reliable. The drainage area above each item is 6.7 and 6.4 square miles, respectively. The findings from the aerial photographic study are summarized in table 10.

Available evidence strongly indicates that this channel system is an important sediment source. The volume of channel erosion equals only a small part of the measured sediment discharge when rainfall and runoff are low as in the 1952-58 period. When rainfall and runoff are abnormally high as in 1951, channel erosion equals a large part of the measured sediment discharge.

Using 216 measurements, from aerial photographs taken in 1937 and 1952, J. C. Brice estimated that 66 acre-feet of material eroded from gullies exceeding 40 cubic yards in size. See preliminary report cited on page 25. In this study he demonstrated that a plot of the volumes from these upland gullies approximated a logarithmic normal distribution.

Special Studies

Additional data were analyzed. These included the landform characteristics, sediment yield, the particle-size distribution of suspended sediment compared to the sediment deposited in Harry Strunk Lake, the channel regime, and the unmeasured sediment load.

Landform Characteristics

In the search for factors that could be related to sediment yield, quantitative values of several landform characteristics such as stream orders, relief ratios, and hypsometric characteristics were determined for several watersheds from topographic maps. The large variation in sediment yields from adjacent watersheds with similar land use encouraged this study.

Stream orders.--In the analysis of stream orders, each channel segment was designated by number according to its position in the system. This method was first proposed by Horton (5) and was then modified by Strahler (16). Horton suggested these methods on the basis that drainage system development depends on resistivity of soil to erosion, runoff intensity, and ground slope. The tributaries or channels furthest upstream were designated order 1, and the channel downstream from the confluence of two first-order channels was designated order 2. Order 3 was assigned to the channel below the confluence of two channels of order 2. This type of order designation was made for the entire Dry Creek drainage and one large branch of the Fox Creek drainage. These watersheds differed in runoff frequency, runoff magnitude, and sediment yield. The order numbers were determined in order to compare stream frequencies of Fox Creek and Dry Creek.

Fox Creek has nearly twice the number of streams per square mile in each order as Dry Creek (fig. 33). Both watersheds have similar exposure, drainage patterns, and direction of flow, and Dry Creek is less than 4 miles east of Fox Creek (fig. 1).

The mean stream lengths (fig. 34) are nearly the same for these two watersheds. The lower stream frequency (fig. 33) in Dry Creek is not compensated for by an increase in channel length.

The drainage density in feet of channel per acre for Fox Creek is also nearly twice the amount for the same order number as in Dry Creek (fig. 35). From a field trip inspection it appeared that the drainage density of Fox Creek was similar to Dry Creek except that the latter had large uneroded flat divides.

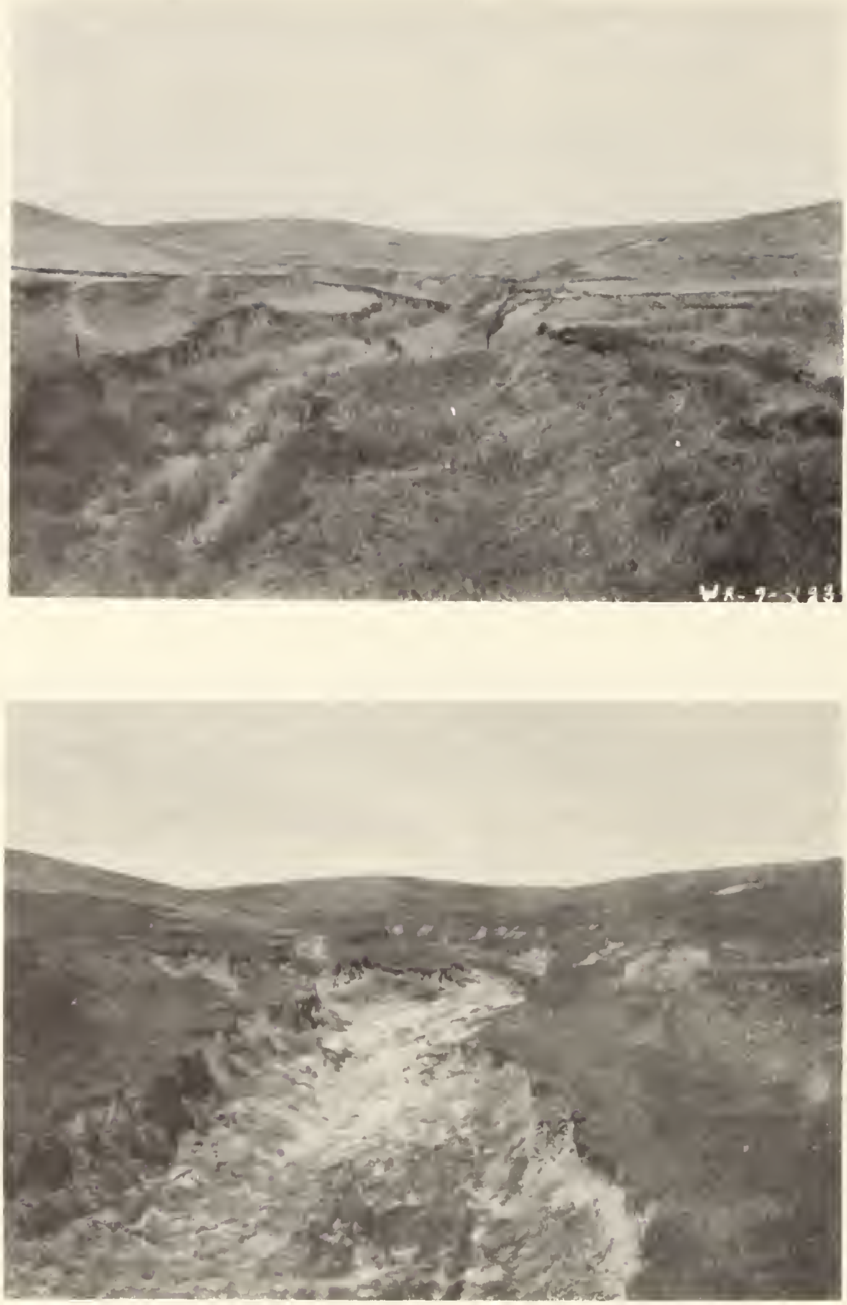


Figure 32.--Dry Creek channel upstream from the bridge on county-line road between Frontier and Lincoln Counties. The upper photograph, which was taken in April 1951, shows upper and lower terrace levels and entrenchment of the channel in the valley alluvium. The lower photograph, which was taken in May 1960, shows definite enlargement of this channel. The position of the fence posts on the east side of the channel indicates that the channel has widened.

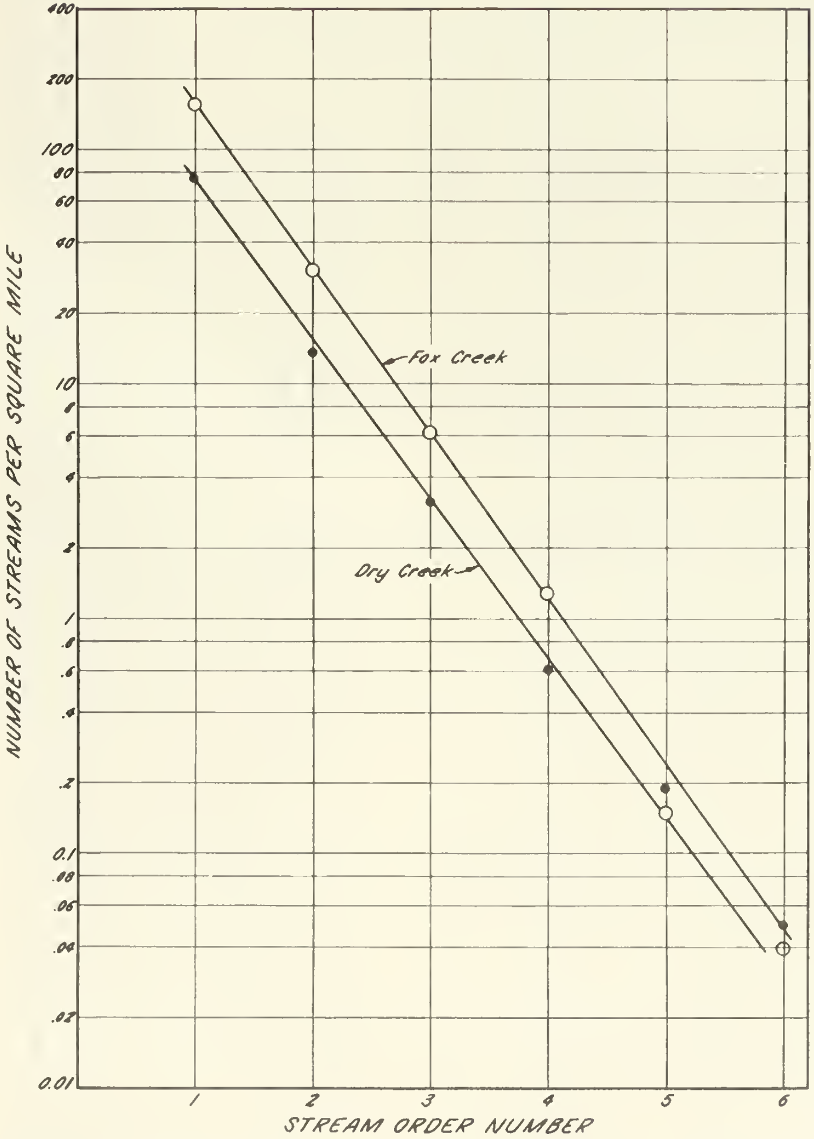


Figure 33.--Frequency of streams for each order for Dry Creek and Fox Creek.

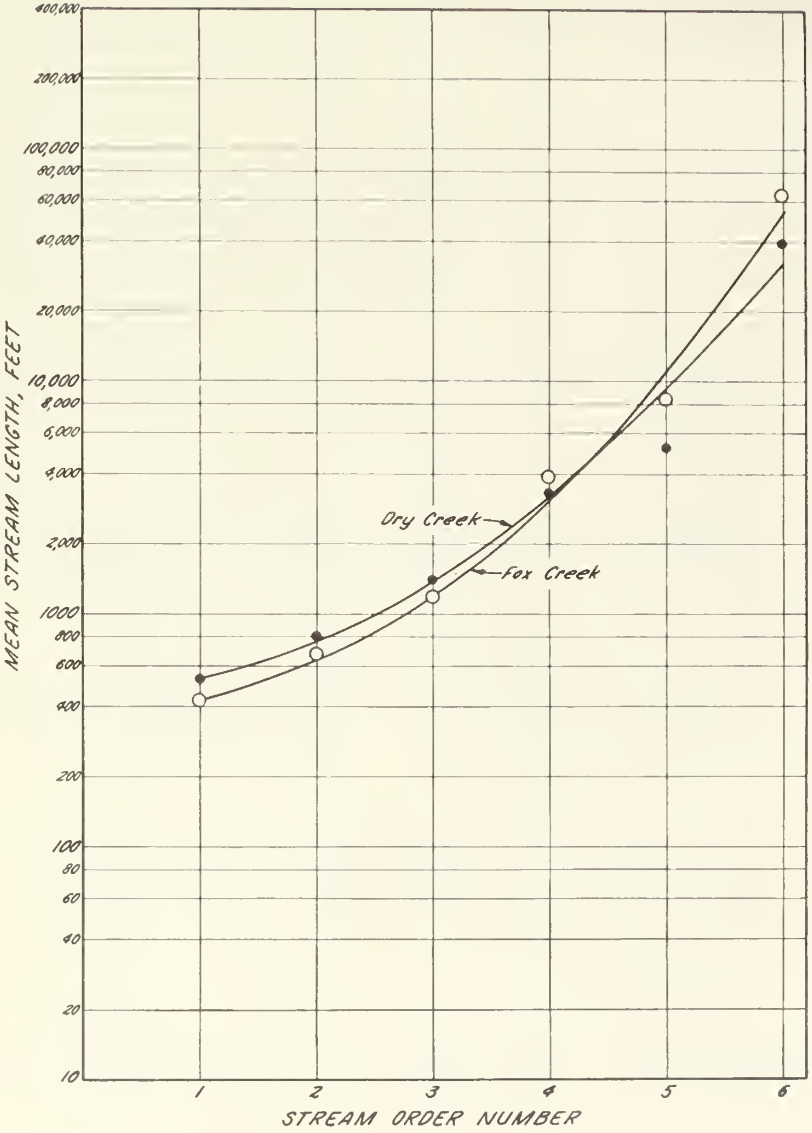


Figure 34.--Mean stream length for each order for Dry Creek and Fox Creek.

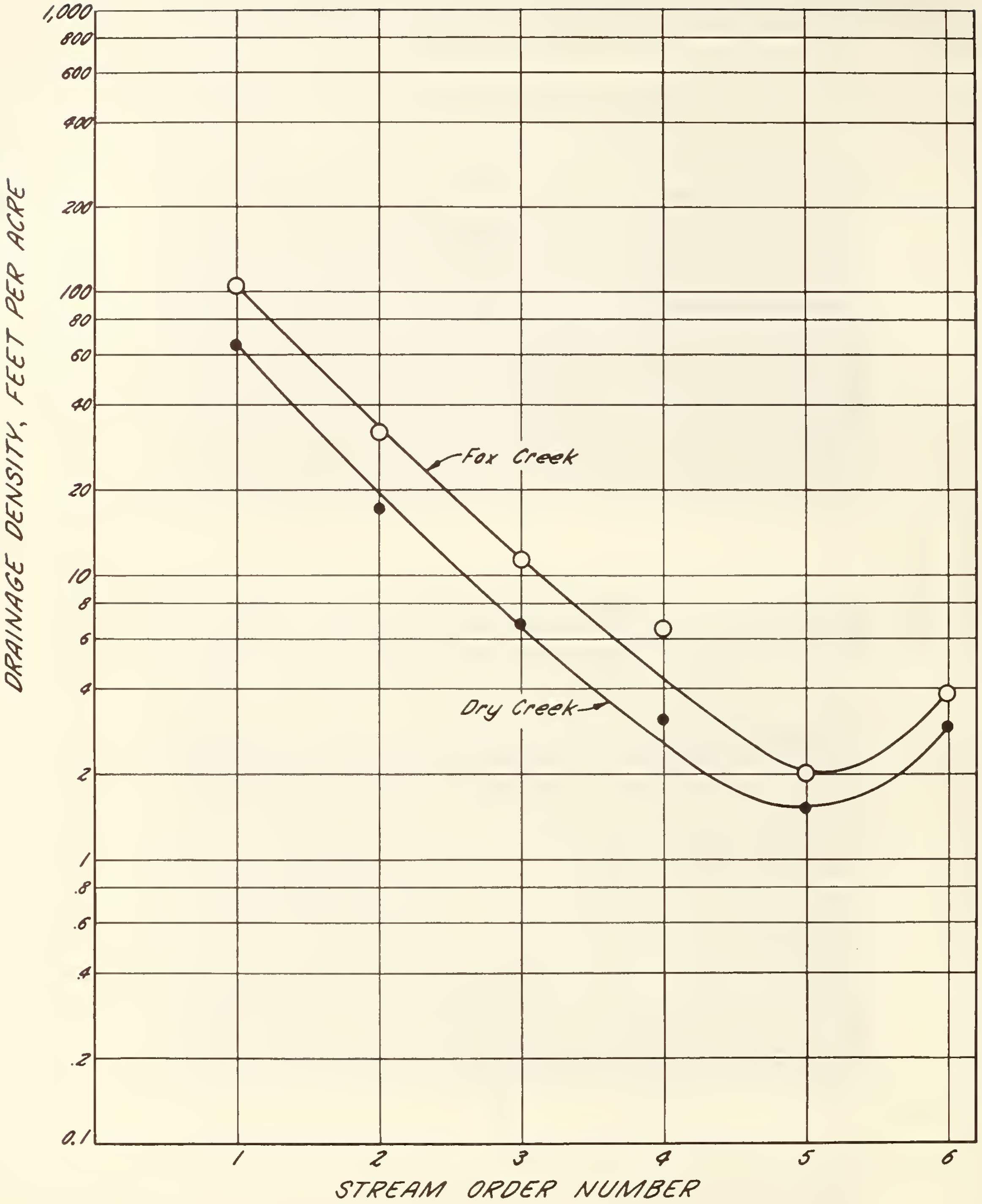


Figure 35.--Drainage density for each stream order for Dry Creek and Fox Creek.

Relief characteristics.--The relief ratios and the channel and valley gradients were determined for each of the gaged watersheds (table 11). The relief ratio was determined by dividing the elevation difference between the highest and lowest points by the subwatershed length roughly parallel to the principal drainage. The channel gradient was determined by dividing the differences in elevation of the upper and lower ends of the channel by the channel length. The valley gradient was determined by dividing the differences in elevation between the upper and lower ends of the valley by the valley length.

The logarithms of the channel gradients, valley gradients, and average annual observed sediment yields were used in correlation analyses of the basins. The relation of channel gradient to sediment yield gave a correlation coefficient, $\underline{r} = 0.80$, which is close to the 5 percent level of significance. The correlation of sediment yield to valley gradient was slightly lower with $\underline{r} = 0.77$. The correlations indicate a good association between channel and valley gradients to sediment yield, but none of these is a direct causal factor. They are probably measures of related sedimentation phenomena--for example, erosional maturity of the watershed.

Hypsometric Curves.--Hypsometric curves are used to quantify watershed topography, and they define a relationship of ratios. The abscissa is the ratio of the area at a selected contour to the entire basin area, and the ordinate is the ratio of the elevation difference between the selected contour and the lowest basin point divided by the elevation difference between the highest and lowest watershed points.

Historically, Langbein (8) suggested using the hypsometric curve in hydrology as a means of estimating the mean depth of snow or its water equivalent over a drainage basin.

Strahler (15) stated that the hypsometric curve can be described by a simple function, where $\underline{y}$ is the relative height of the basin, $\underline{x}$ is the relative area, $\underline{z}$ is the numerical exponent, and $\underline{d}$ and $\underline{a}$ are numerical constants. With this function, comparisons can be made numerically of constants and exponents among drainage basins.

For Brushy, Dry, Fox, and Mitchell Creeks, the exponents, $\underline{z}$, were determined graphically, and areas for hypsometric integral were measured from the curves (fig. 36). The integral values indicate the stage of geological erosion. Each of these subwatersheds is in the equilibrium stage, according to Strahler.

Particle-Size Distribution of Suspended Sediment and Deposits in Harry Strunk Lake

A comparison of the particle-size distribution of the suspended sediment at the gaging stations with sediment deposits in Harry Strunk Lake was made graphically by plotting the data on logarithmic normal paper. An average particle-size distribution curve for suspended sediment was computed from the samples analyzed by the visuals accumulation or sieve methods and by pipette methods. All these suspended-sediment data were published by the Geological Survey (18). In figures 37 through 42, the solid lines are the averages, while the dash lines indicate the limits between which about two-thirds of the observations fall.

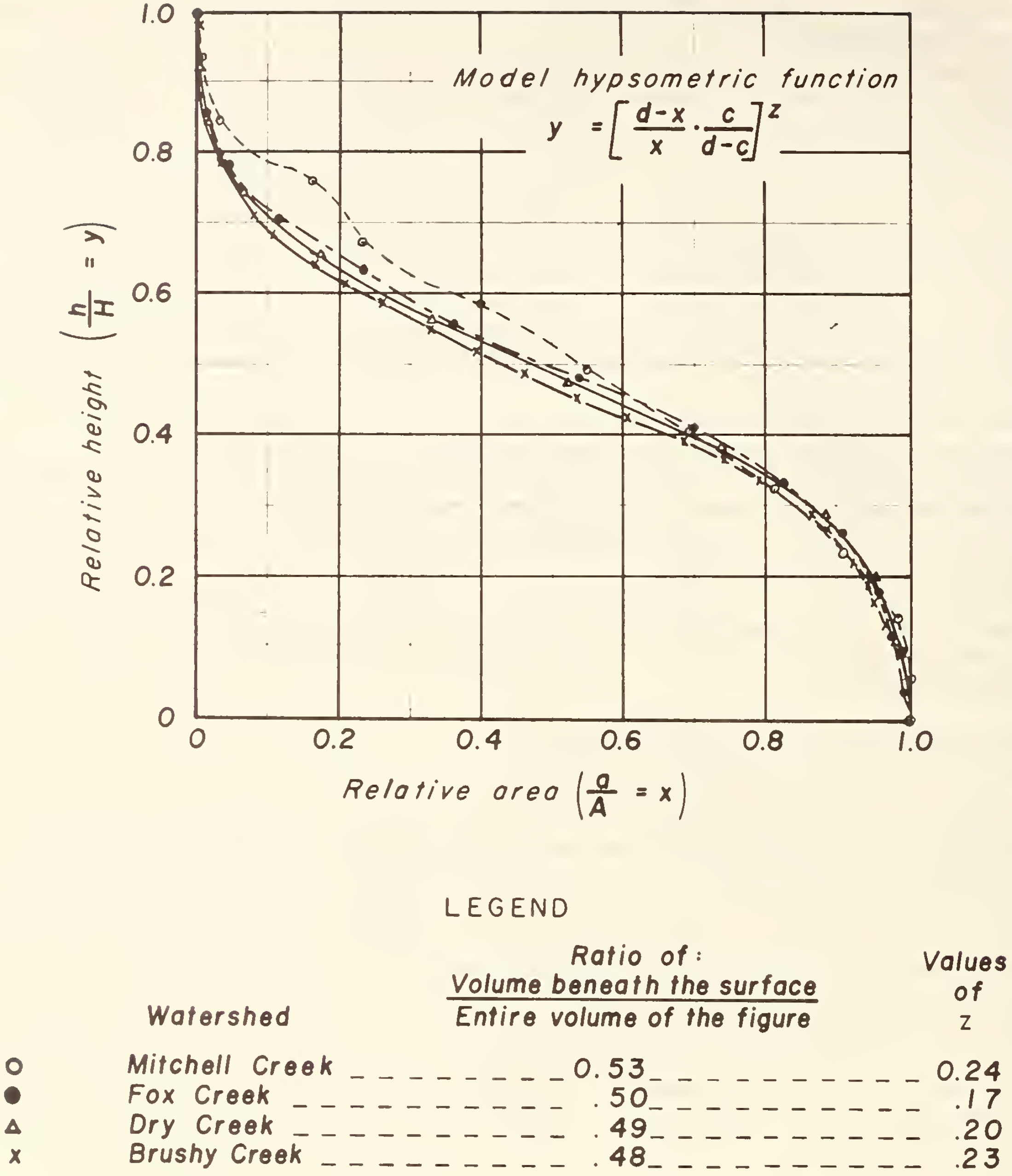
The size distributions of deposit samples from Harry Strunk Lake (16) are shown in figures 43 and 44. Sediment range numbers begin at the dam and increase as you go upstream. Note the increased mean-particle size of deposits with increased distance from the dam. The percentage of sediment finer than 0.6 millimeter is about the same in the middle of the lake as in the incoming streamflow.

Channel Regime

Regime was described by Sir Claude Inglis (6) as follows:

> "Under natural conditions, regime is essentially a balance between accretion and erosion over a period of time; it applies to rivers and tidal estuaries, as well as canals taking off from, and influenced by, the varying conditions in the rivers from which they draw their supplies. The changes that take place during the cyclic period are generally far too complex to be computed; however, if a channel is in regime it will return at the end of the period of the cycle to approximately the same condition as at the beginning of the cycle, a year or more earlier."

According to the above statement, cyclic erosional processes occur within a year, but in the semiarid region of southwestern Nebraska the cyclic period might take several years. In some



LEGEND

	Watershed	Ratio of: Volume beneath the surface / Entire volume of the figure	Values of z
○	Mitchell Creek	0.53	0.24
●	Fox Creek	.50	.17
△	Dry Creek	.49	.20
x	Brushy Creek	.48	.23

Figure 36.--Hypsometric curves for Mitchell, Fox, Dry, and Brushy Creeks.

years with low rainfall, there is little direct runoff. In other years with high rainfall, severe erosion occurs, and huge amounts of sediment are transported.

Results from studies of the regime concept can be useful in the design of flood channels and for predicting the behavior of natural alluvial channels where runoff and sediment discharge are regulated by reservoirs and other water-control works. The Medicine Creek Basin data were partially analyzed to determine if the regime relationship could be developed for this area.

The data for five of the six stations were compiled from USGS Quality of Surface Water publications (18) and unpublished records. These gaged sites were selected because of the geographic location, topography, suitability of gaging reach, and importance of data that could be

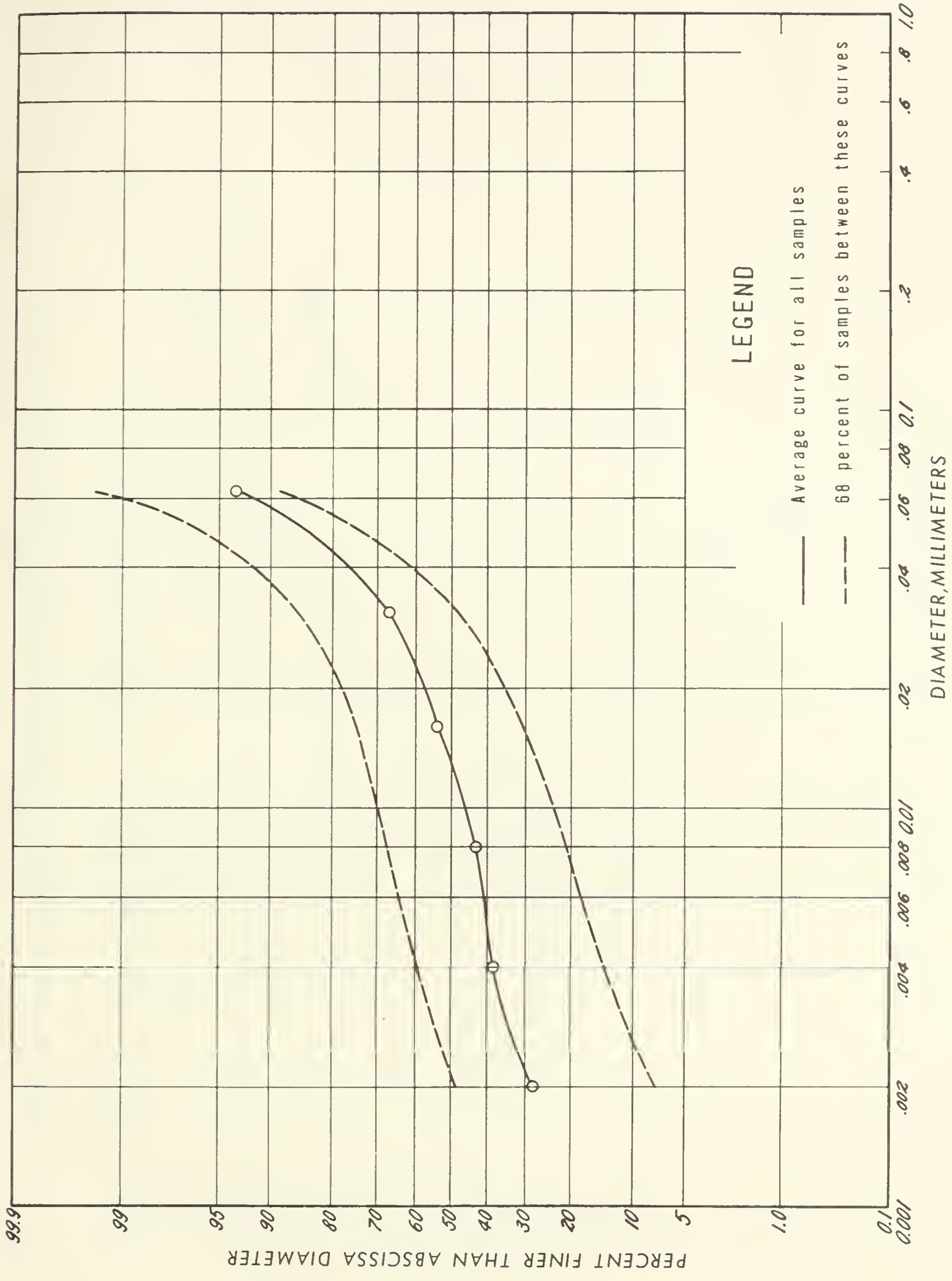


Figure 37.--Average distribution of particle sizes of suspended-sediment samples from Brushy Creek, Nebr., 1951-58.

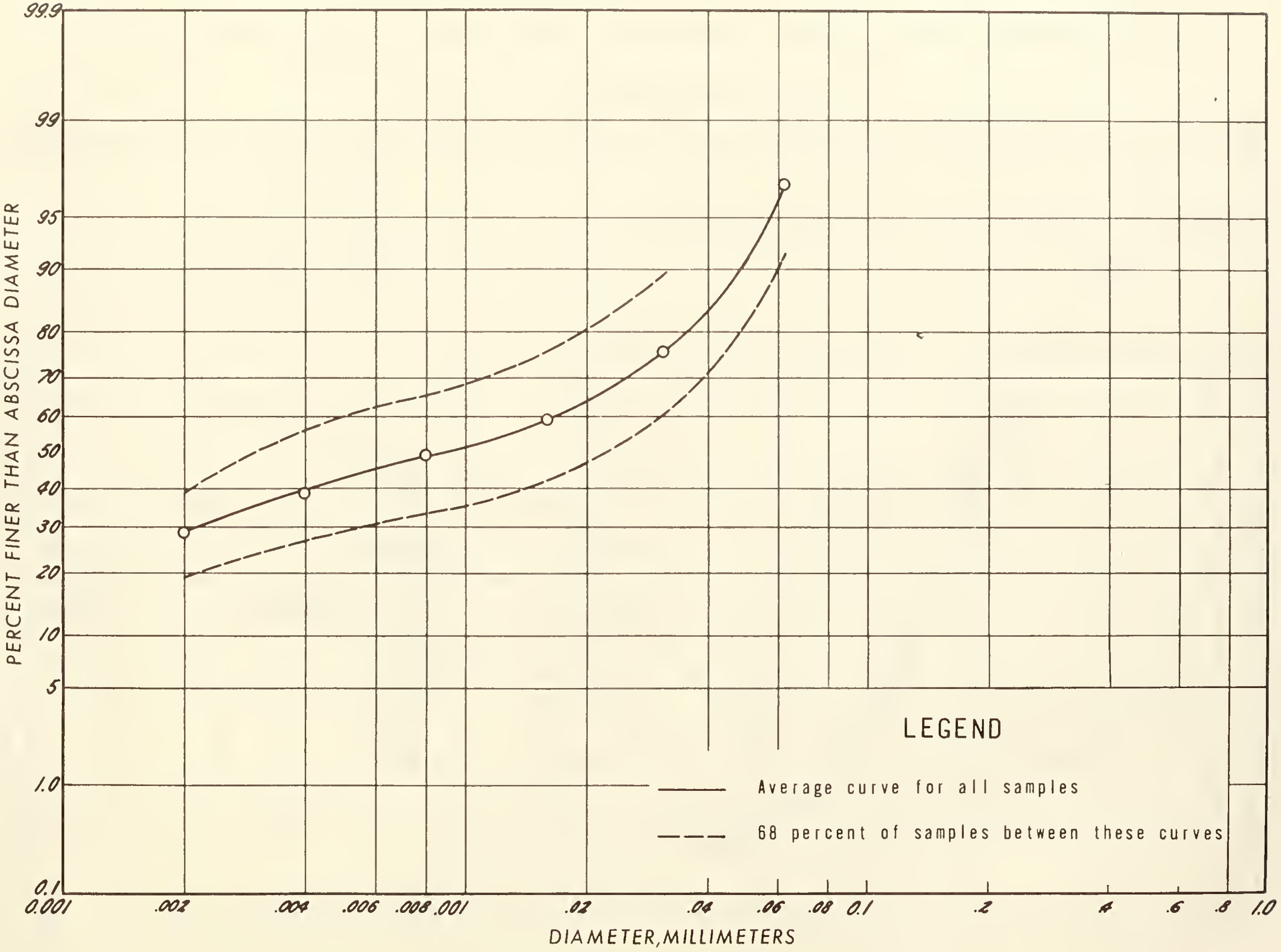


Figure 38.--Average distribution of particle sizes of suspended-sediment samples from Dry Creek, Nebr., 1951-58.

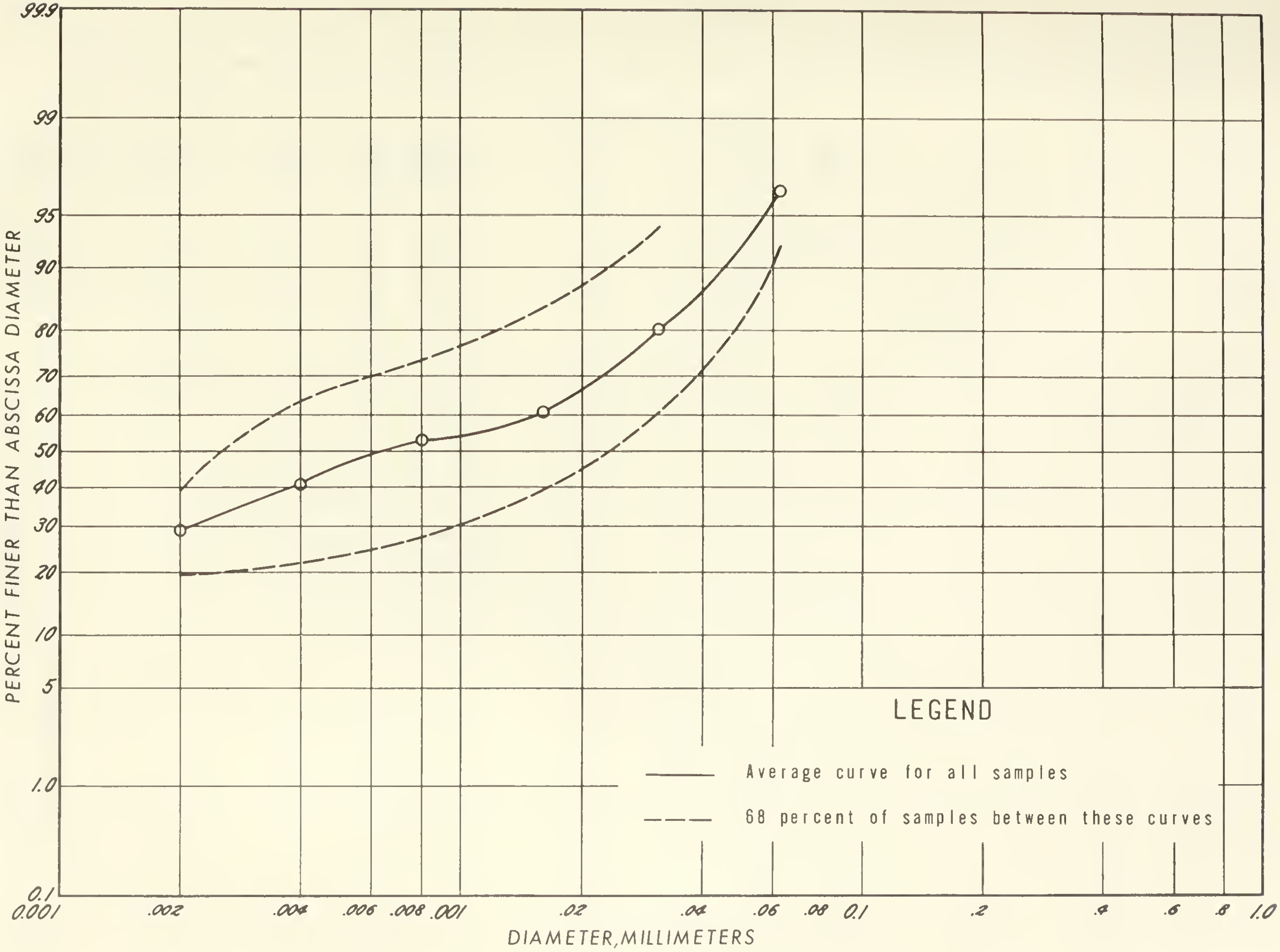


Figure 39.--Average distribution of particle sizes of suspended-sediment samples from Fox Creek, Nebr., 1951-58.

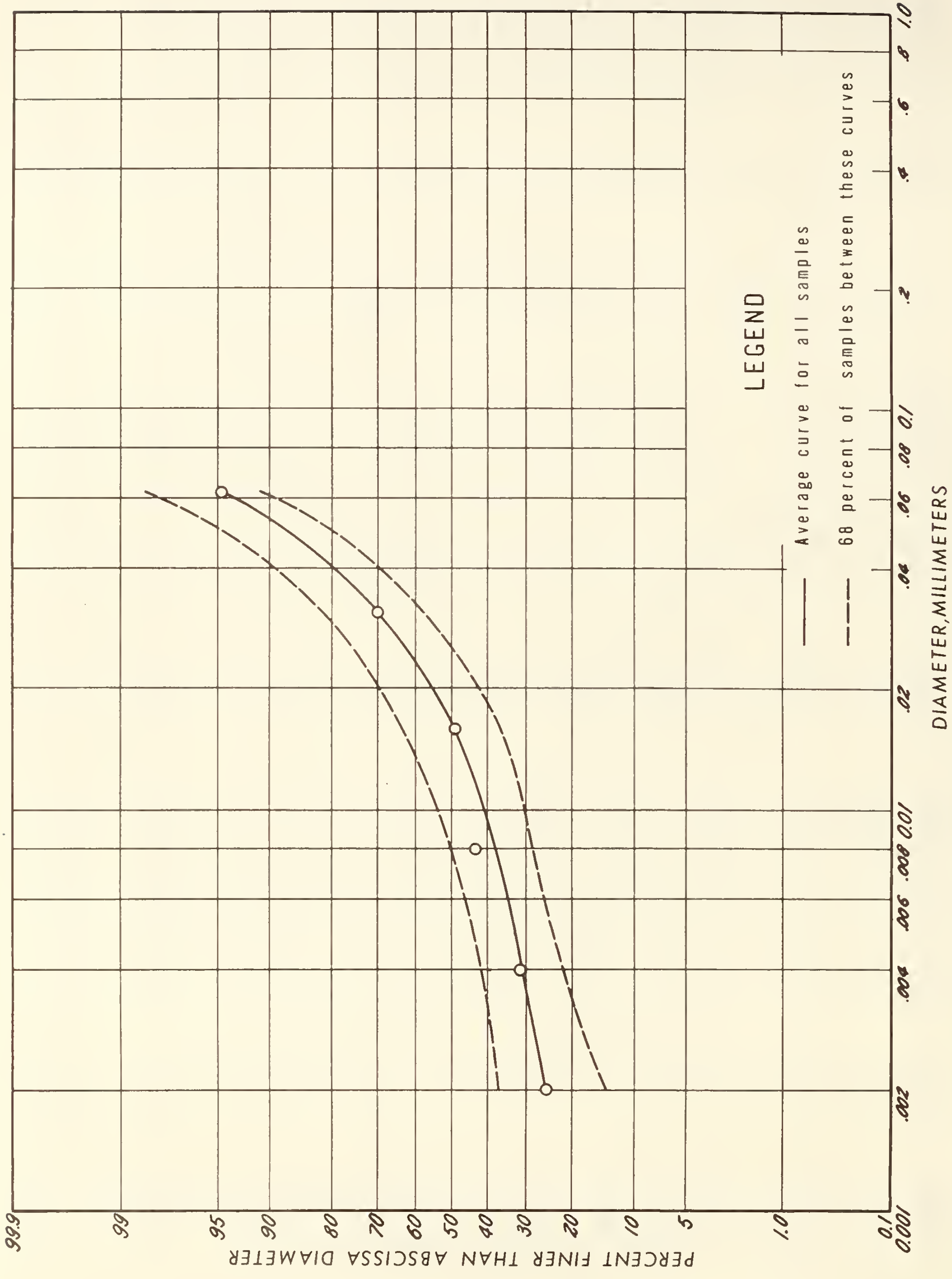


Figure 40.--Average distribution of particle sizes of suspended-sediment samples from Medicine Creek at Maywood, 1951-58.

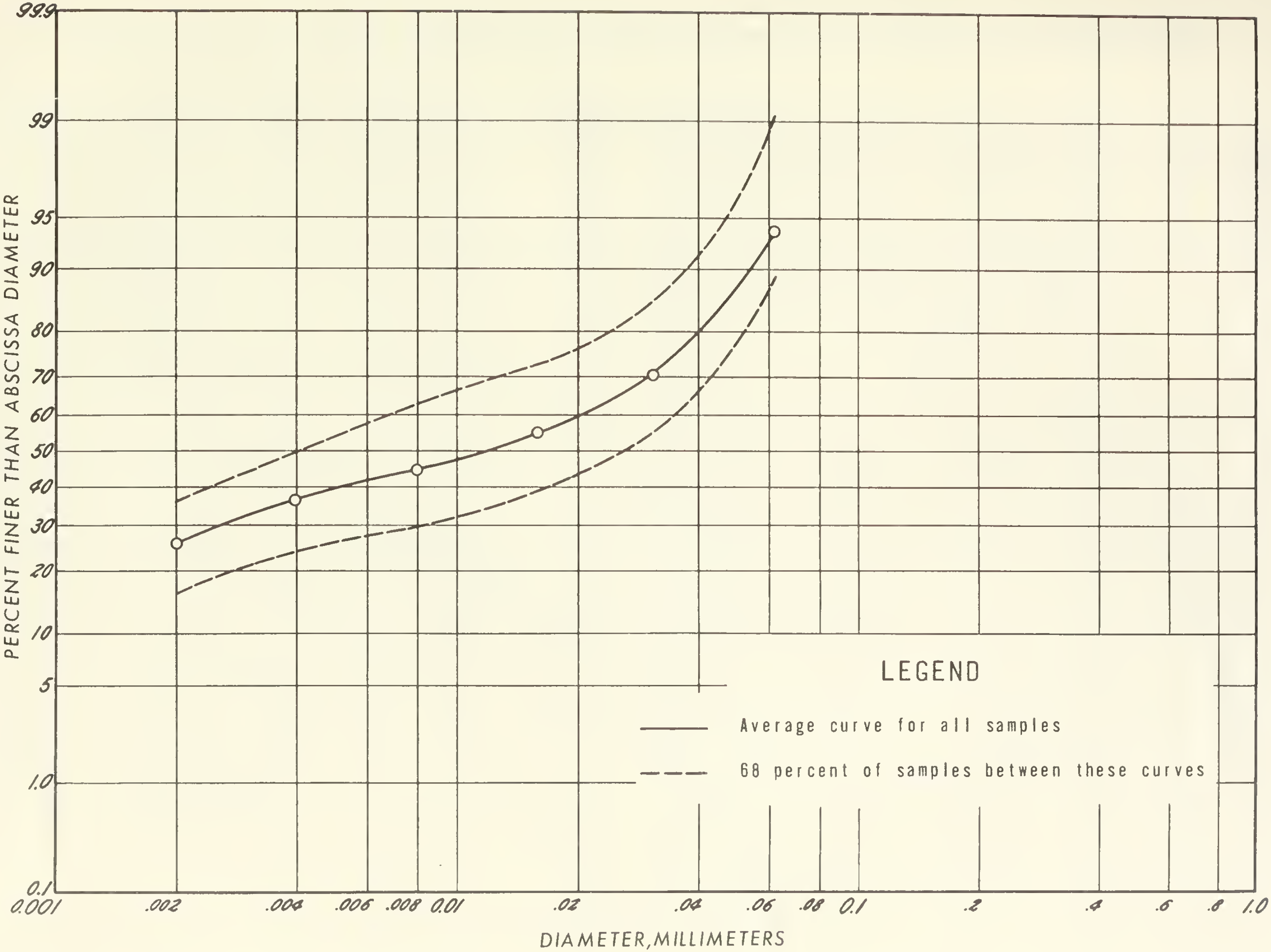


Figure 41.--Average distribution of particle sizes of suspended-sediment samples from Medicine Creek above Harry Strunk Lake, 1951-58.

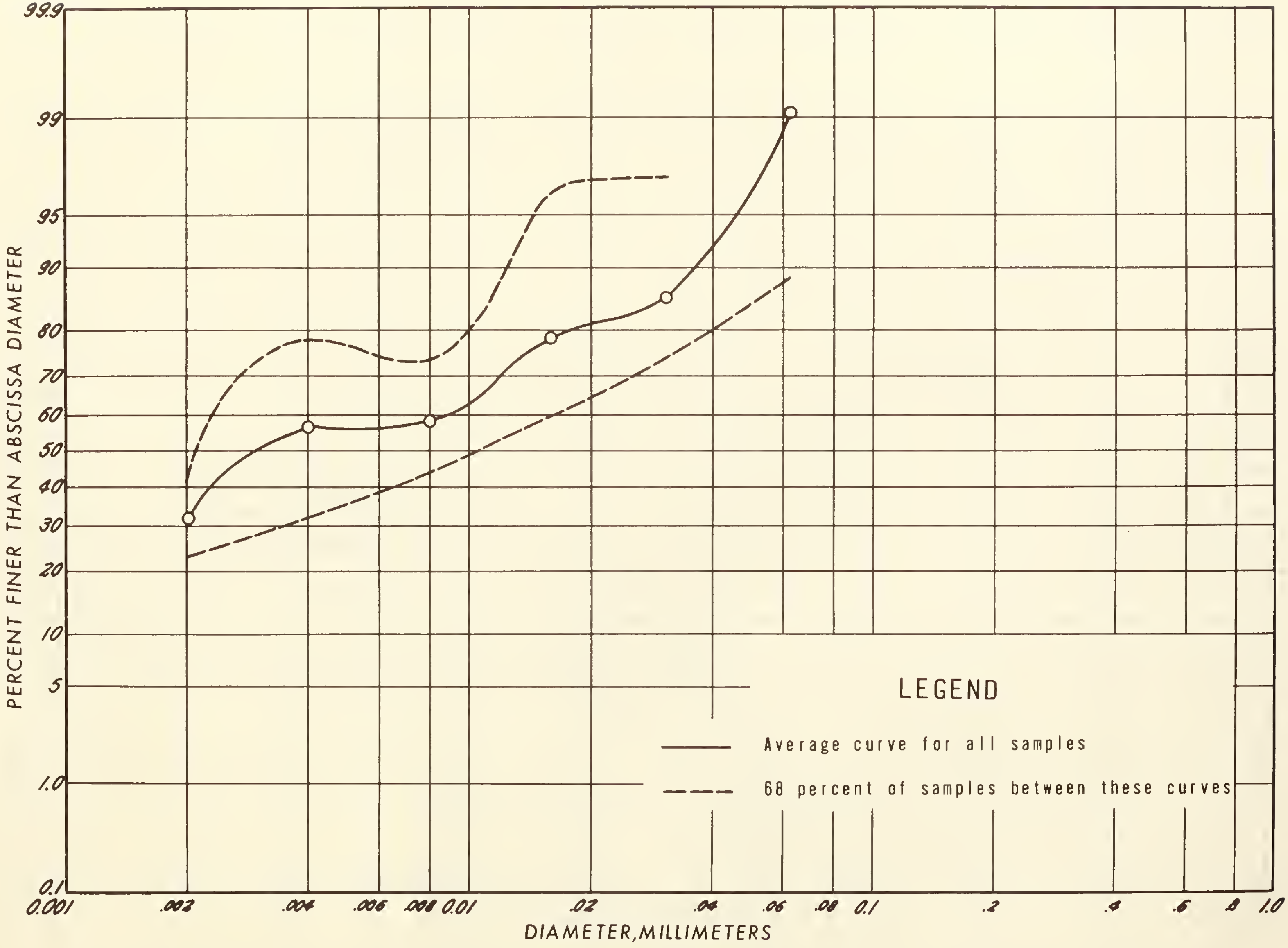


Figure 42.--Average distribution of particle sizes of suspended-sediment samples from Mitchell Creek, Nebr., 1951-58.

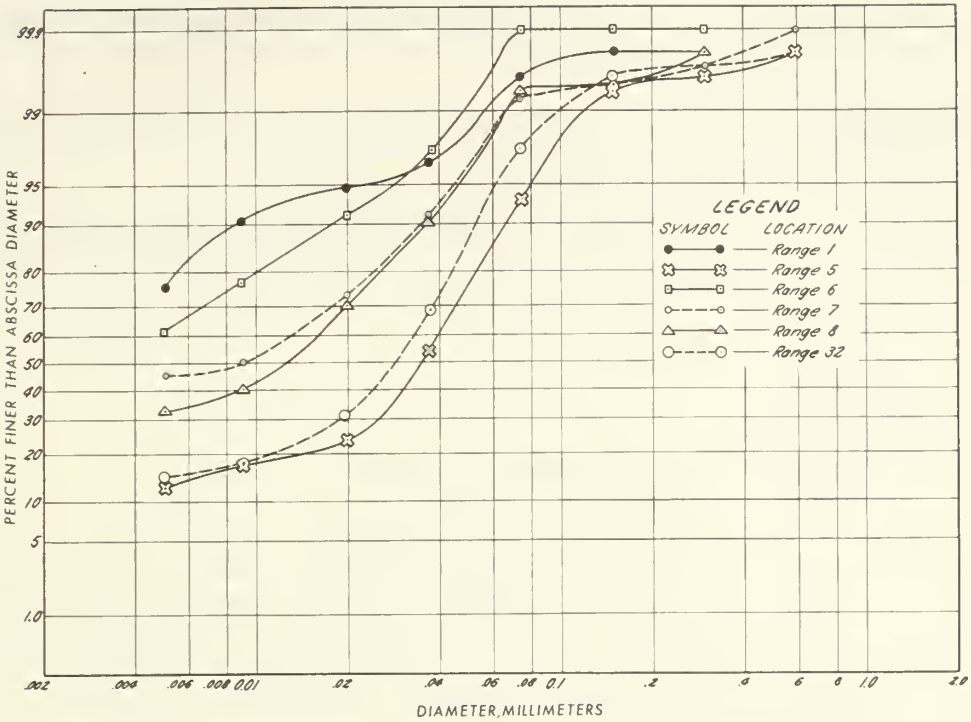


Figure 43.--Average distribution of particle sizes of suspended-sediment samples from ranges 1, 5, 6, 7, 8, and 32 across Harry Strunk Lake, 1951.

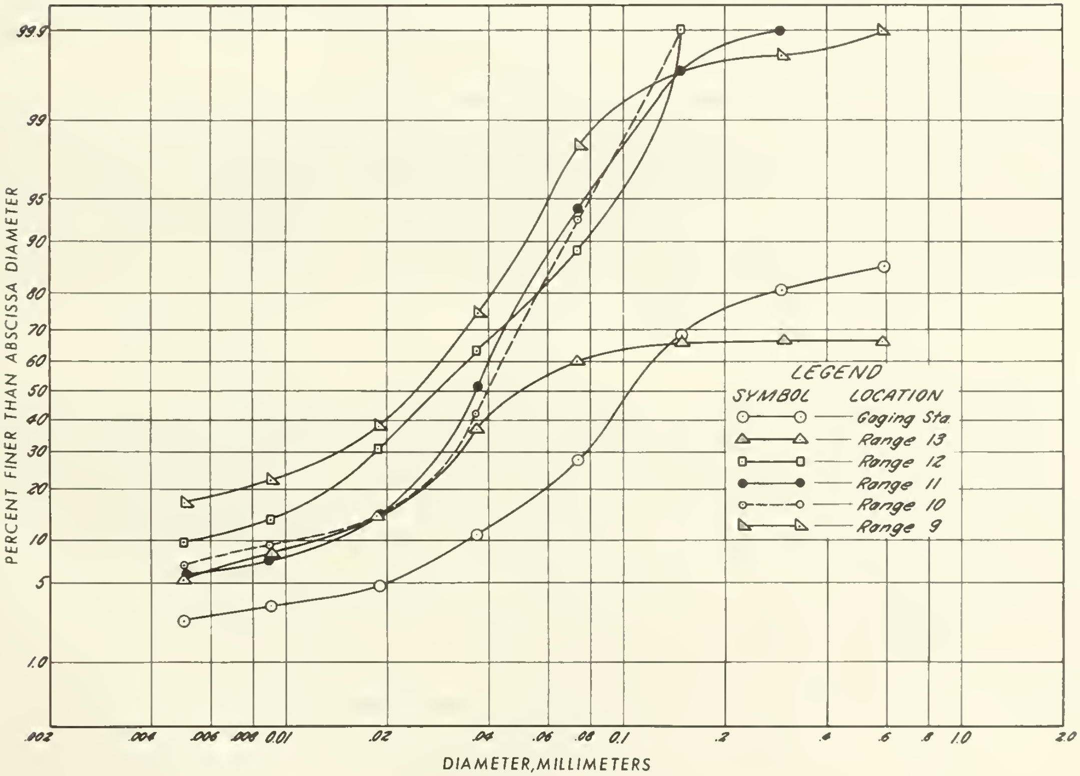


Figure 44.--Average distribution of particle sizes of sediment samples from ranges 9 through 13 across Harry Strunk Lake, 1951.

collected. The sites are on stable sections, and therefore do not necessarily represent the entire drainage systems. Nevertheless, these sites are on alluvium and do represent channel conditions for a large part of each of their watersheds.

The data for each site consist of instantaneous values for cross-sectional area, velocities, width, mean depth, runoff discharge, and sediment concentration. Some values had to be interpolated from curves in order to get all necessary concurrent data.

In the initial part of this study, a method was used for relating velocity, width, depth, area, and sediment load to the runoff discharge. This is similar to the method used by Leopold and Maddock (9). These are power equations, as follows:

$$w = aQ^b;\ v = kQ^m;\ d = cQ^f;\ L = pQ^j$$

where w = width
d = mean depth
v = mean velocity
Q = runoff discharge in cubic feet per second
L = suspended sediment in tons per day
a, b, c, f, j, k, m and p are numerical constants.

The numerical constants for the power equations were determined by graphical and statistical procedures for the five stations (table 12). In the graphical plottings, the mean curves fitted well with the station data. However, only flows that were confined to the channels were used.

The numerical constants have values similar to those tabulated by Leopold and Maddock (9). The instantaneous sediment-rating curves, except for Fox Creek ($j = 1.65$), have exponent, j, values between 1.3 and 1.4.

In another graphical approach, velocities, v, were plotted versus sediment load, L (tons per day), which was multiplied by channel slope, S_c (feet per foot), and divided by the square root of cross-sectional area, A (feet). Dry, Brushy, and Fox Creeks appear to fit into one group, regardless of their differences in frequency of runoff discharge, channel shape, and upstream channel erosion (fig. 45). For Mitchell Creek and Medicine Creek above Harry Strunk Lake (fig. 46), the data plotted slightly different from those in figure 45.

When the slopes from the V versus $(L \times S_c)/A^{\frac{1}{2}}$ plots on logarithmic paper are compared with z values for hypsometric curves (fig. 36), the regime and hypsometric exponent values for each creek are of nearly the same magnitude and have a linear relationship. The channel regime concept is strongly supported by the graphical relationships of sediment load, runoff rates, cross-sectional areas, and channel slopes with velocity. The hypsometric curve parameters, indicating the erosional maturity, topographical steepness, and other landforming features, may be a way to evaluate the status of regime development.

Unmeasured Sediment Transport

The measured suspended-sediment values are less than the true average concentration because the equipment samples only to 0.3 foot from the channel bottom. In the bottom 0.3 foot the sediment concentration is higher than in the rest of the vertical section, with the magnitude depending upon the sizes of the suspended material and bed material, velocity, and depth of flow.

Several technical articles have been published describing methods of computing the amount of unmeasured sediment. In a method developed by Colby (3) the mean velocity and concentration of measured suspended-sand sizes (courser then 0.062 mm) are used. Lane and Borland (7) presented a discussion and table by Maddock to judge the amount of unmeasured sediment from the materials in the channel and in the watersheds. The estimated values from both of these approaches were tabulated in appendix table 28 for Dry, Brushy, Mitchell, and Medicine Creek stations near Maywood and above Harry Strunk Lake. The values estimated from the table by Maddock were usually higher than those from Colby's method. For all streams, the unmeasured load was generally less than 3 percent of the measured load, from Colby's method; thus, the average annual sediment yield would be about 3 percent greater than the average annual suspended-sediment yield.

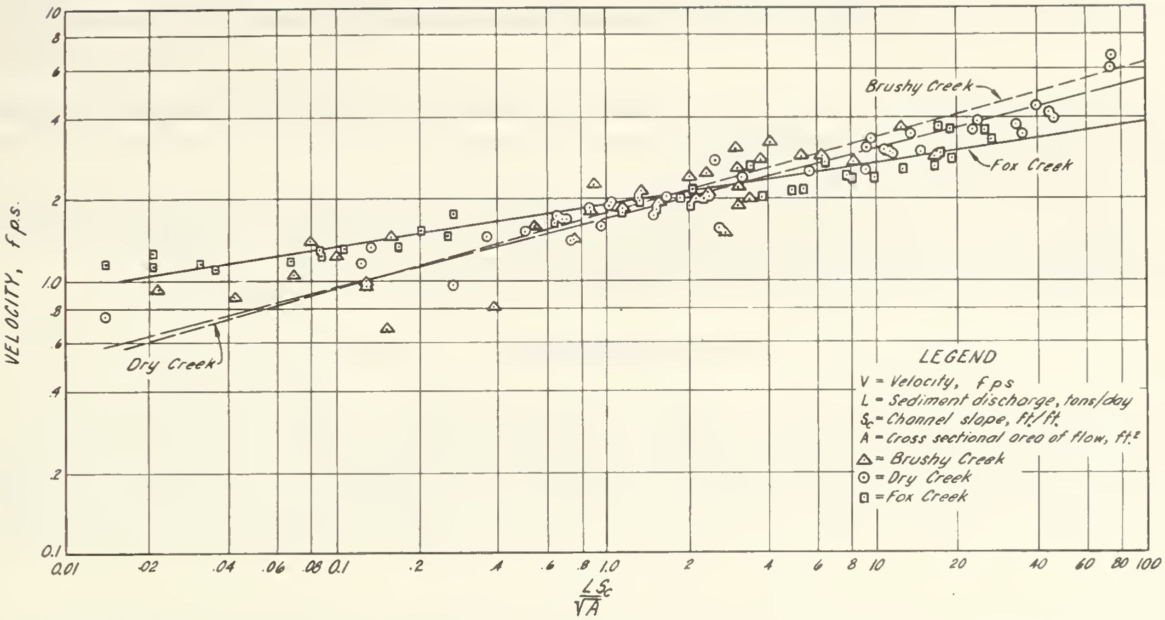


Figure 45.--Channel regime relationship for Brushy, Fox, and Dry Creeks.

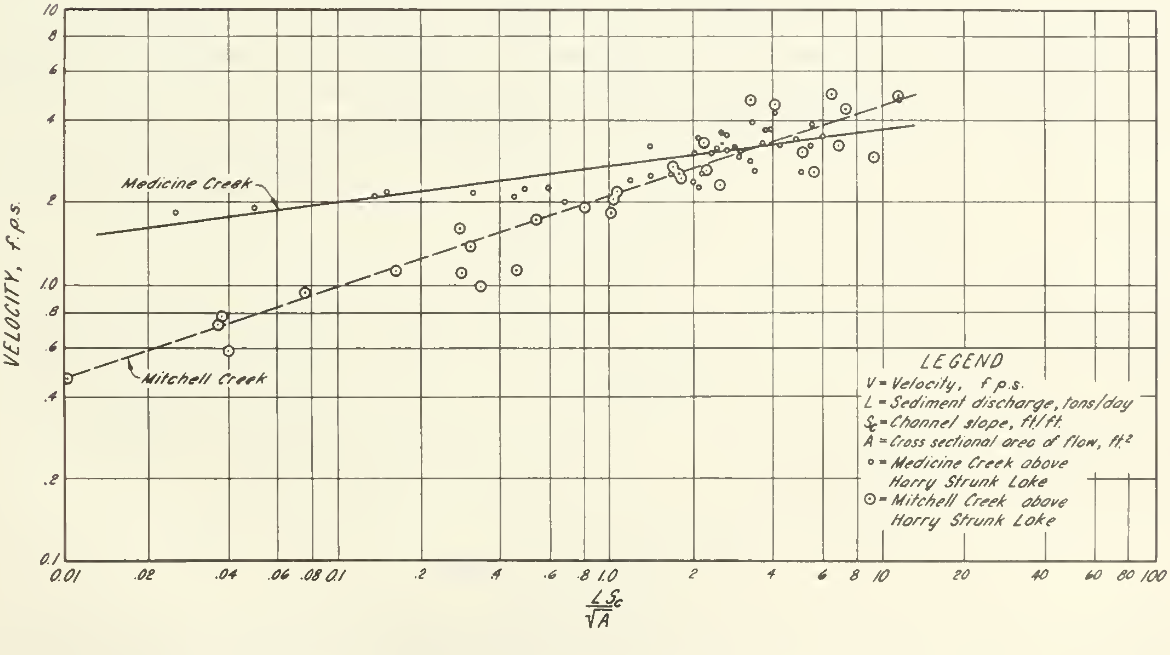


Figure 46.--Channel regime relationship for Medicine Creek and Mitchell Creek.

DISCUSSION AND EVALUATION

Much good and usable data were obtained during the cooperative investigations in the Medicine Creek Watershed notwithstanding atypical climatic conditions and the lack of a long-term base with which to compare recent data.

Several different analytical procedures and methods of evaluation were tried to extract as much information as possible from the study. Some discussion of the basic plan, data collection, and the evaluation and significance of the reported results follows.

Precipitation

Fifteen rain gages were operated in the 680-square-mile Medicine Creek Watershed to determine rainfall amounts and intensities. However, other studies made since the project started have shown that this density was too light and the variations between individual gage readings during storms were too great to permit adequate estimates of storm rainfall (14). Because of this inadequacy further storm analyses could not be pursued with any confidence.

Annual rainfall-runoff relations were developed and used because the rain-gage network more adequately portrayed annual rainfall. However, it has not been proved that a sparse network of rain gages will produce adequate estimates of annual precipitation over short periods of time. The seemingly random occurrences of convection and squall-line storms over large areas cause some variations in annual records of individual gages. In many years of record this randomization might average out, but such an occurrence is unlikely in 8 years.

Streamflow and Sediment Data

The streamflow and suspended-sediment measurements used in this study were obtained at six stations on streams having 20 to 548 square miles of drainage area. In addition, observations were started in 1953 on two small watersheds. These two did not provide data for the only wet year (1951) during the period of study. All of the large watersheds were mixed with regard to soils, topography, land use, vegetative conditions, and conservation treatment. Much good data were obtained on land use and treatment, topography, and channel system, but the effects of these factors on runoff and sediment concentration were indistinguishable.

The raw data on streamflow and sediment are subject to the usual uncertainties involved in gaging ephemeral streams having flash-flood runoff events, natural controls, and because of difficulties of communications and access. Although every effort was made to use the best equipment and techniques to calibrate properly all stations for gaging streamflow and for adequately sampling suspended sediment, the agency collecting these data classified much of them as poor. However, much usable and worthwhile information was obtained in an area not previously gaged. The streamflow records are continuous for the period of study and should be valuable in the future to Federal, State, and private agencies.

All streams gaged in this study discharge into Harry Strunk Lake. Most of the sediment passing the lower stream-gaging stations probably was deposited in the lake, but the quantity is unknown because the outflow from the lake was sampled infrequently.

Flow-Duration Curves

Flow-duration curves for the short-term stations were plotted for the 8 years of record, and these were then adjusted by the station-index method using the Cambridge station. The rates of the long-term (1936-58) stream-gaging station at Cambridge were affected by the construction of the dam above the station on Medicine Creek in 1948. After 1948 the Cambridge station gaged the streamflow as regulated by Harry Strunk Reservoir. The unit area inflow to the lake and the total drainage area were utilized to simulate unregulated streamflow to the Cambridge station after this date.

Sediment-Rating Curves

An examination of the daily sediment-rating curves of the several stream-gaging stations used in this study (figs. 21 to 26) revealed the following:

1. The relative importance of the various gaged watersheds as sediment producers.
2. Different sediment-rating relationships exist for the wet year 1951 and for the dry period 1952-58.
3. Although probably useful for planning purposes, sediment content varies considerably for selected rates of streamflow.

Some of these figures show sediment sample data with spreads of one to two logarithmic cycles. Estimates of total suspended sediment based on such sampling data and rate of streamflow may not be very reliable. From the available data, it was impossible to determine the causes of the variations in sediment loads for various runoff rates.

Long-Term Sediment Yields

The accepted methods of estimating long-term sediment yields were investigated. Because of the type of data available from this study the daily flow-duration and sediment-rating curve method was used.

The long-term sediment yield estimates based on this method are questionable, however, because of the unknown adequacy of the flow-duration curves and the sediment-rating curves. The first unanswered question is, "Do the flow-duration curves (corrected or unaltered) reliably estimate the long-term flow duration for this physiographical area?" The second and third unanswered questions relate to the sediment-rating curve; (a) does the relation of water discharge to sediment load based on short-term data represent the long-term relation in loessial soils, and (b) is the relation well enough defined throughout the entire range of water discharged? However, the relative importance of watersheds as sediment producers is shown.

Furthermore, for the ephemeral streams, the greatest portion of the sediment yield is thought to be produced by the large runoff events. Both the flow-duration and sediment rating curves are supported by few data in this high-discharge region. Usually, the curves were extended beyond the range of the available data in order to predict long-term sediment yields. This makes these yields of questionable reliability.

CONCLUSIONS

The hydrologic data and other information obtained for the period 1951-58 are inadequate for firm conclusions on the interrelated influences of weather, soil, land use, and geomorphic processes upon erosion, streamflow and sediment yield.

The period of record collection was short, considering the fact that the climate during the study period was atypical and that most of the rainfall, streamflow, and sediment data were obtained during a period of severe drought. There are limitations, too, in terms of the detail in which it was possible to pursue some of the phases of the investigation. Nevertheless, the investigations provide a valuable documentation of occurrences during the study period and much useful information for planning and developing land- and water-resource programs for areas in the Medicine Creek Watershed and vicinity. If an agency working in this area can supplement the existing information with additional records from a typical period, results of the investigation reported herein will be even more useful.

This report has been prepared primarily to document the study, preserve some of the records, and indicate where other records are filed. Some analyses were made in an attempt to clarify the significance of the acquired data. Findings of the analyses should be used with caution for long-range projections unless supplemental information can be obtained.

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APPENDIX

Table 1.--Data collection contributions of participating agencies, Medicine Creek Watershed in Nebr., 1951-58

A = field work; B = office work; C = financial support

Data Collected on	Agricultural Research Service	Bureau of Reclamation	Geological Survey	Soil Conservation Service
Runoff		C	A, B	
Precipitation		A, B, C[1]		
Suspended sediment		C	A, B	
Channel sections	A, B, C	A, B, C		
Reservoir surveys	A, B, C	A, B, C	A, B	
Land Use	A, B, C			A, B, C
Topography			A, B, C	
Soil conservation survey				A, B, C
Aerial Photographs				A, B, C

[1] Assisted by U.S. Weather Bureau

TABLE 2.--Precipitation station history,
Medicine Creek Watershed, Nebr.,
1951-58

Station	Location	Period of record	Type of gage	Observer
Stockville 5 SSW- - - -	NE¼, 29 6 N, 27 W	4-9-51 to 2-10-52	Recording	E. E. Ramsey
Stockville 5 S - - - -	NW¼, 26 6 N, 27 W	2-11-52 to 9- -58	----do----	L. A. Owens
Stockville 6 NE - - - -	SE¼, 6 7N 26 W	4-11-51 to 2-11-52	Nonrecording	L. G. Koch
Stockville 6 NNE- - - -	SW¼, 35 8 N, 27 W	2-12-52 to 8-17-54	----do----	K. C. White
Moorefield 6 SE - - - -	SW¼, 30, 8 N, 26 W	2-18-54 to 4-11-56	----do----	W. G. Palmer
-------do------- - - -	SW¼, 30, 8 N, 26 W	4-12-56 to 9- -58	----do----	Mildred Widick
Maywood 7 WSW - - - - -	NW¼, 28, 8 N, 30 W	5-1-51 to 9- -58	----do----	M. H. Christensen
Wellfleet 8 NE- - - - -	SW¼, 8, 10N, 29 W	4-10-51 to 9- -58	----do----	H. E. Detour
Curtis 5 SW - - - - - -	SW¼, 13, 7N, 29 W	4-9-51 to 10-27-54	----do----	H. L. Johnston
Curtis 5 SSW - - - - -	NE¼, 24, 7 N, 29 W	10-28-54 to 9- -58	----do----	Bessie M. Cole
Moorefield 3 NNW- - - -	NE¼, 31, 9 N, 27 W	4-12-51 to 12-6-51	Recording	R. H. Martens
Moorefield 3 NW - - - -	SE¼, 20, 9 N, 27 W	12-7-51 to 9- -58	----do----	C. H. Nelson
Curtis 14 N - - - - - -	SW¼, 16, 10 N, 28 W	4-12-51 to 9- -58	Nonrecording	Ralph Gutherless
Medicine Creek Dam- - -	NW¼, 25, 5 N, 26 W	10-1-51 1/	----do----	Bureau of Reclamation
Curtis 4 N - - - - - -	SE¼, 4, 8 N, 28 W	2-9-54 to 9- -58	Recording	R. F. Piest
Moorefield 6 NNW- - - -	NE¼, 6, 9 N, 27 W	2-9-54 to 9- -58	----do----	J. N. Dempcy
Moorefield - - - - - -	SE¼, 5, 8 N, 27 W	7-16-47 1/	Nonrecording	A. M. Mercer
Cambridge - - - - - - -	SW¼, 29, 4 N, 25 W	7-1-48 1/	----do----	R. L. McKinney
Stockville- - - - - - -	NE¼, 33, 7 N, 27 W	7- -47 1/	----do----	M. R. Johnson
Wellfleet - - - - - - -	NW¼, 15, 9 N, 30 W	7-16-47 1/	----do----	C. S. Olson
Curtis -- - - - - - - -	SE¼, 28, 8 N, 28 W	1-1-53 1/	Recording	E. L. Crawford

1/ Continuing

TABLE 3.--Runoff gaging and sediment sampling station history, Medicine Creek Watershed, 1951-58

(C = minimum of one sample per day with more on charging stage;
Q = daily sampling but no flow during most of year;
T = intermittent sampling)

Station	Drainage area (sq.mi.)	Gaging period of record	Sampling		
			Period of record	Equipment 1/	Number of 1/ observations
Medicine Creek near Maywood - -	74	4/25/51-9/30/58	4/24/51-9/30/58	D 43	C
Medicine Creek above Harry Strunk Lake. - - - - - - - -	548	1/19/50 2/	4/2/51-9/30/58	D1 H1	C
Medicine Creek below Harry Strunk Lake. - - - - - - - -	656	1/19/50 2/	6/20/51-8/31/57	G 1	T
Medicine Creek at Cambridge -	680	12/10/36 2/	3/27/51-6/30/57	D 43	C
Brushy Creek near Maywood - -	72	4/25/51-9/30/58	4/25/51-9/30/58	D 49	C
Fox Creek at Curtis - - - - - -	73	3/29/51-9/30/58	3/29/51-9/30/58	D 49	C
Dry Creek near Curtis - - - -	20	3/27/51-9/30/58	3/29/51-9/30/58	D 43	Q
Mitchell Creek above Harry Strunk Lake. - - - - - - - -	52	4/28/50	4/2/51-9/30/57	D1 H1	T
Dempcy Draw at Dempcy pond near Moorefield.- - - - - - -	52	8/23/53-9/30/58	8/23/53-9/30/58	3/	T
Tobiassen Draw on Tobiassen farm near Curtis. - - - - - -	34	9/16/55-9/30/58	9/16/53-9/30/58	D1 H1	T

1/ See "Literature Cited" section, reference (19).

2/ Continuing.

3/ Automatic single-stage sampler.

TABLE 4.--Annual and daily precipitation at Curtis, Nebr., 1894-1958 (No record for 1906-09)

Year	Annual precipitation	Departure from average	Highest daily precipitation
	Inches	Inches	Inches
1894	8.63	-12.73	----
95	22.31	.95	----
96	28.45	7.09	----
97	25.25	3.89	----
98	21.03	- .33	----
1899	19.93	- 1.43	----
1900	20.35	- 1.01	----
01	21.99	.63	----
02	25.89	4.53	----
03	24.65	3.29	----
1904	23.47	2.11	----
05	37.19	15.83	----
10	18.96	- 2.40	----
11	33.80	12.44	3.91
12	27.20	5.84	----
1913	30.46	9.10	2.56
14	19.10	- 2.26	3.10
15	38.25	16.89	3.10
16	17.83	- 3.53	1.20
17	16.28	- 5.08	1.60
1918	21.41	.05	2
19	18.80	- 2.56	1.10
20	21.50	.14	2.90
21	18.70	- 2.66	1.90
22	13.89	- 7.47	1.70
1923	26.25	4.89	2.40
24	15.80	- 5.56	2.25
25	18.11	- 3.25	1.80
26	17.48	- 3.88	1.58
27	22.15	.79	1.82

TABLE 4.--Continued

1928	26.93	5.57	2
29	22.42	1.06	4.40
30	33.65	12.29	2.30
31	19.76	- 1.60	2
32	18.53	- 2.83	2.20
1933	17.13	- 4.23	3
34	10.93	-10.43	1.30
35	25.78	4.42	3.28
36	14	- 7.63	1.45
37	19.37	- 1.99	1.90
1938	16.46	- 4.90	1.12
39	14.80	- 6.56	1.20
40	17.23	- 4.13	2.20
41	22.16	.80	2.17
42	25.29	3.93	3.25
1943	14.87	- 6.49	2.20
44	23.97	2.61	1.70
45	1/ 21.65	.29	1.80
46	25.12	3.76	2.82
47	23.65	2.29	5.10
1948	17.05	- 4.31	2
49	1/ 24.15	2.79	2.05
50	1/ 22.57	1.21	1.68
51	31.61	10.25	3.23
52	12.63	- 8.73	1.10
1953	18.59	- 2.77	1.56
54	13.21	- 8.15	1.87
55	15.27	- 6.09	1.62
56	13.09	- 8.27	1.61
57	23.85	2.49	2.20
1958	22.27	.91	2.60
Totals	- - - - -	- - - - -	103.83
Average	21.36	- - - - -	2.21

1/ Estimated

TABLE 5.--Estimated long-term runoff and sediment yields from flow-duration and sediment-rating curves method, 1951-58 flow-duration curves (unadjusted), Medicine Creek above Harry Strunk Lake

1	2	3	4	5	6	7
Limits	Interval	Middle Ordinate	Runoff discharge	Sediment discharge	Runoff discharge	Sediment discharge
Percent	Percent	Percent	C.f.s.-days	Tons per day	C.f.s.-days	Tons per day
0 -0.0055	0.0055	0.00275	6,400	1,050,000	0.3520	57.75
.0055- .006	.0005	.00575	5,000	740,000	.0250	3.70
.006 - .007	.001	.0065	4,750	680,000	.0475	6.80
.007 - .008	.001	.0075	4,600	660,000	.0460	6.60
.008 - .01	.002	.009	4,350	610,000	.0870	12.20
.01 - .03	.02	.02	3,700	480,000	.7400	96
.03 - .05	.02	.04	3,300	410,000	.66	82
.05 - .07	.02	.06	3,100	370,000	.62	74
.07 - .01	.03	.85	2,900	340,000	.87	102
.1 - .3	.2	.2	1,850	180,000	3.70	360
.3 - .5	.2	.4	860	59,000	1.72	118
.5 - .7	.2	.6	600	35,000	1.20	71
.7 - .9	.2	.8	490	26,500	.98	53
.9 -1.1	.2	1	415	21,500	.83	43
1.1 -1.3	.2	1.2	370	18,000	.74	36
1.3 -1.5	.2	1.4	340	16,000	.68	32
1.5 -1.7	.2	1.6	310	14,000	.62	28
1.7 -2.3	.6	2	260	11,000	1.56	66
2.3 -3.7	1.4	3	180	5,000	2.52	70
3.7 -5	1.3	4.35	130	2,200	1.69	26.60
5.0 10	5	7.5	87	640	4.35	32
10 20	10	15	71	340	7.10	34
20 40	20	30	62	220	12.40	44
40 60	20	50	55	145	11	29
60 80	20	70	46	78	9.20	15.60
80 100	20	90	30	17	6	3.40
Total discharge -					1/69.7375	2/1504.65

1/ Annual runoff discharge = 69.7375 x 365 x 1.9835 = 50,490 acre-feet per year.

2/ Annual sediment discharge = 1504.65 x 365 = 550,000 tons per year.

TABLE 6.--Estimated long-term annual runoff and sediment yields, Medicine Creek above Harry Strunk Lake, annual frequency series method

Frequency, 10 highest years	Runoff	Suspended sediment
	C.f.s.-days	Tons
100	51,000	3,900,000
50	47,000	2,800,000
33.3	44,500	2,250,000
25	42,700	1,900,000
20	41,000	1,650,000
16.7	40,000	1,500,000
14.3	39,000	1,350,000
12.5	38,200	1,220,000
11.1	37,200	1,100,000
10.0	36,500	1,020,000
Subtotal (10 highest years)	417,100	18,690,000
Frequency by 10-year intervals for remaining 90 years		
6.72	33,800	750,000
3.98	30,200	480,000
2.84	27,500	330,000
2.20	25,200	235,000
1.81	23,200	162,000
1.53	21,400	123,000
1.33	19,400	83,000
1.17	17,300	52,000
1.038	13,700	20,500
Subtotal - - - - - - - - - - -	211,700	2,235,500
Subtotal x 10 (90 years) - -	2,117,000	22,355,000
Grand total (100 years)	2,534,100	41,045,000
Average annual runoff	25,340	410,450

TABLE 7.--Observed and Estimated average annual runoff

Medicine Creek Watershed, Nebr.

Creek	Drainage area (sq.mi.)	Units	Observed		Estimated long-term runoff					
					Annual series 1/		Daily flow-duration curves			
			1951-58	1952-58	1951-58	1951-58 2/	1951-58	1951-58 3/	1952-58	1952-58 3/
Brushy	73.74	Acre-ft./yr.	1,806	1,336	1,780	2,060	1,950	2,840	1,250	3,280
		Inch/yr.	0.459	0.339	0.451	0.522	0.496	0.722	0.317	0.834
Dry	20.45	Acre-ft./yr.	852	364	720	850	1,050	1,690	370	1,790
		Inches/yr.	0.781	0.334	0.663	0.782	0.963	1.549	0.340	1.641
Fox	76.63	Acre-ft./yr.	6,755	5,628	6,820	7,480	5,960	7,770	4,860	6,610
		Inches/yr.	1.653	1.377	1.669	1.830	1.458	1.901	1.189	1.617
Medicine at Maywood	74.17	Acre-ft./yr.	18,598	17,665	18,490	18,880	18,670	19,110	17,720	19,490
		Inches/yr.	4.701	4.463	4.674	4.772	4.719	4.831	4.479	4.926
Medicine above Harry Strunk Lake	548.6	Acre-ft./yr.	50,162	44,200	50,250	53,920	50,490	57,130	42,940	54,240
		Inches/yr.	1.715	1.510	1.717	1.843	1.725	1.952	1.467	1.854
Mitchell	52.19	Acre-ft./yr.	1,602	853	1,060	1,180	1,840	3,280	1,040	3,550
		Inches/yr.	0.575	0.306	0.379	0.425	0.661	1.178	0.373	1.275

1/ Calculated from probability distribution.
2/ Adjusted to long-term precipitation.
3/ Adjusted to 1938-58 runoff record.

TABLE 8.--Observed and estimated average annual suspended-sediment yield

Medicine Creek Watershed, Nebr.

Creek	Drainage area (sq.mi.)	Units	Observed		Estimated long-term yield					
					Annual series[1]		Flow-duration method			
			1951-58	1952-58	1951-58	1951-58[2]	1951-58	1951-58[3]	1952-58	1952-58[3]
Brushy	73.74	Tons/yr.	67,010	33,720	69,000	84,000	75,000	167,000	42,000	225,000
		Tons/sq.mi./yr.	908	457	930	1,140	1,020	2,270	570	3,050
Dry	20.45	Tons/yr.	59,000	18,340	45,000	54,000	74,000	218,000	20,000	221,000
		Tons/sq.mi./yr.	2,884	897	2,190	2,630	3,630	10,670	990	10,800
Fox	76.63	Tons/yr.	72,630	7,780	78,000	94,000	80,000	253,000	23,000	139,000
		Tons/sq.mi./yr.	947	102	1,080	1,300	1,050	3,310	300	1,810
Medicine at Maywood	74.17	Tons/yr.	29,250	13,230	31,000	34,000	41,000	54,000	30,000	54,000
		Tons/sq.mi./yr.	394	178	420	460	550	720	400	730
Medicine above Harry Strunk Lake	548.6	Tons/yr.	530,280	170,710	410,000	494,000	549,000	1,046,000	255,000	764,000
		Tons/sq.mi./yr.	965	311	750	900	1,000	1,900	460	1,390
Mitchell	52.19	Tons/yr.	---	[4]31,860	58,000	67,000	98,000	274,000	46,000	305,000
		Tons/sq.mi./yr.	---	[4] 610	1,110	1,280	1,890	5,260	880	5,850

1/ Calculated from probability distribution.
2/ Adjusted to long-term precipitation.
3/ Adjusted to 1938-58 runoff record.
4/ Observations were from 1952 through 1957.

TABLE 9.--Observed channel erosion - Dry Creek and main tributaries

Medicine Creek Watershed, Nebr.

Creek or channel item No.	Channel reach stationing	Reach length	Volume of channel erosion					
			May 1951 to May 1952		May 1952 to Apr. 1956		Apr. 1956 to Aug. 1960	
		ft.	Cu. Ft.	Acre ft.	Cu. ft.	Acre ft.	Cu. ft.	Acre ft.
Main stem Dry Creek:								
7	176+60 to 225+10	4,850	253,200	----	----	----	----	----
8A	225+10 to 249+80	2,470	568,300	----	----	----	----	----
	249+80 to 261+50	1,170	134,600	----	----	----	----	----
8B	261+50 to 328+80	6,730	545,100	----	----	----	----	----
8C	328+80 to 374+90	4,610	685,500	----	----	----	----	----
8D	374+90 to 442+50	6,760	399,500	----	----	----	----	----
8E	442+50 to 455+90	1,340	355,200	----	----	----	----	----
8F	455+90 to 483+30	2,740	7,400	----	----	----	----	----
1	483+30 to 493+30	1,000	244,400	----	4,800	----	----	----
1	493+30 to 503+30	1,000	210,700	----	44,840	----	----	----
	Subtotal - - - - - - - -		3,403,900	78.1	49,640	1.14		
Tributary channels:								
	442+50 thru item 3	4,060						
3A	0+00 to 6+10	610	161,700	----	15,300	----	85,200	----
	6+10 to 20+60	1,450	83,100	----		----		----
	20+60 to 30+60	1,000	191,000	----	1/ -47,700		-232,800	----
3	30+60 to 40+60	1,000	342,800	----	37,200	----	579,600	----
	Subtotal - - - - - - - -		778,600	17.9	4,800	.11	432,000	9.91
	384+30 thru item 5	3,000						
	0+00 to 7+80	780	87,800	----	----	----	----	-----
5	7+80 to 20+00	1,220	161,500	----	-12,600	----	----	----
	20+00 to 30+00	1,000	123,000	----	13,800	----	----	----
	Subtotal - - - - - - - -		372,500					
	366+90 thru item 10	1,900						
10A	0+00 to 18+70	1,870	276,600	----	----	----	----	----
10	18+70 to 19+00	30	14,800	----	----	----	----	----
	Subtotal - - - - - - - -		291,400	6.7	----	----	----	----
	Total - - - - - - - - - -		4,846,400	111.3	----	----	----	----

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1/ Negative values indicate deposition rather than erosion.

TABLE 10.--Channel overfall advancement for

items 1 and 3,

Dry Creek Subwatershed, Medicine Creek Watershed, Nebr.

Period	Average annual rainfall	Item 1		Item 3	
		Channel advancement	Average annual advancement	Channel advancement	Average annual advancement
	Inches	Feet	Feet	Feet	Feet
1937-46	20.1	----	----	325	32.5
1947-50	21.9	----	----	211	53.7
1937-50	20.6	696	49.7	536	38.6
1951	31.6	250	250	350	350
1952-55	15	50	12.5	50	12.5
1956-58	18.2	60	20	227	75.6
1956-60	18.8	----	----	395	79
1937-58	19.7	956	44.5	---	----
1937-60	19.7	----	----	1,331	55.5

TABLE 11.--Relief ratio, channel gradient, and valley

gradient of Medicine Creek Watershed, Nebr., 1955

Watershed	Relief ratio	Channel gradient	Valley gradient
	Ft. per ft.	Ft. per ft.	Ft. per ft.
Brushy Creek - - - - - -	0.00704	0.00428	0.00445
Dry Creek - - - - - - -	.00763	.00520	.00523
Fox Creek - - - - - - -	.00555	.00384	.00395
Medicine Creek above Maywood	.00454	.00259	.00279
Medicine Creek above Harry Strunk Lake - - - - -	------	.00287	.00321
Mitchell Creek - - - - -	.00548	.00364	.00410

TABLE 12.--Numerical constants of runoff discharge for the width, depth, area, velocity, and sediment-load power equations, Medicine Creek Watershed, Nebr.

Creeks	$W = aQ^{b}$		$d = cQ^{f}$		$A = acQ^{b+f}$		$v = kQ^{m}$		$L = pQ^{j}$	
	a	b	c	f	ac	$b+f$	k	m	p	j
Brushy - - - -	5.15	0.339	0.297	0.415	1.53	0.758	0.642	0.243	14.10	1.30
Dry - - - -	6.20	.309	.195	.434	1.25	.738	.800	.258	14.10	1.40
Fox - - - -	3.74	.447	.347	.378	1.30	.810	.770	.190	1.56	1.65
Medicine above Harry Strunk Lake	6.85	.372	.170	.436	1.11	.809	.900	.178	2.54	1.40
Mitchell - - -	10.80	.133	.231	.520	2.50	.653	.403	.346	5.78	1.40

TABLE 13.--Runoff and sediment data[1]

Tobiassen draw near Curtis, Nebr.

Medicine Creek Watershed, Nebr.

Water year and date	Duration of flow	Water discharge	Suspended sediment		Runoff
			Concentration	Load	
	Hr.	C.f.s.	P.p.m.	Tons	Acre-ft.
1954 water year:					
May 15-16	8.25	0.52	4,980	5.69	0.36
May 17	11	.10	6,490	1.08	.09
June 1-2	3	.05	3,800	.08	.01
June 13	4	.06	4,130	.26	.02
June 14-15	8	.07	2,560	.27	.05
Sept. 8	2.4	.28	6,440	.85	.06
Total[2]				8.23	.59
1955 water year:					
May 17-18	4.75	.12	[3]3,000	.20	.05
May 25-26	9.17	.38	1,580	1.26	.29
May 26	8.25	.13	[3]3,000	.35	.09
June 15	4.75	.08	[3]3,000	.13	.03
June 16	1.50	.08	[3]3,000	.04	.01
June 16-17	3.5	.08	[3]3,000	.10	.02
Total				2.08	.49
1956 water year:					
June 18	6.83	.15	[3]3,000	.32	.08
July 5	6.83	.97	[3]3,000	2.24	.55
Total				2.56	.63

TABLE 13.--Continued

1957 water year:					
Apr. 22	4.25	0.08	2,200	0.11	0.03
May 3	6.75	.25	596	.19	.14
May 11	3.25	.02	3/ 200	5/	.01
May 13-14	15.50	.86	3/ 360	1.42	1.10
May 16-17	25.25	.90	3/ 340	1.66	1.88
June 26-27	9	.03	3/ 550	.03	.02
July 7	10.50	2.70	3,080	33.4	2.34
July 14	16	1.62	2,530	27.4	2.14
July 21	4	.03	3/ 150	5/	.01
Sept. 13	10	.30	3/ 220	.12	.25
Total -				64.33	7.92
1958 water year:					
Mar. 19-30		20	3/1,200	3/ 8	3/ 5
Mar. 30-Apr. 2	58.75	.04	3/1,100	3/ .3	.203
Apr. 4-5	7.75		3/ 300	3/ .001	.00223
Apr. 27	4.25	.16	4/3,600	4/ .28	.057
May 1-2	6.75	.02	3/1,300	3/ .2	.110
May 14	8	.30	4/1,200	4/ .32	.198
July 16	3.50	.02	600	.004	.005
July 18-19	6.75	4.36	14,500	47.9	2.43
July 20-21	8.50	.46	3/1,100	3/ .5	.323
Sept. 13-14	6.50	1.18	6,740	5.81	.633
Sept. 19	10	4.49	12,700	63.9	3.71
Total -				127.215	12.67

1/ Geological Survey records, subject to revision.

2/ Maximum observed concentration, 26,000 p.p.m.

3/ Estimated.

4/ Partly estimated.

5/ Trace.

TABLE 14.--Computations of Storage

Unnamed tributary to East Fork Curtis Creek at Dempcy pond near

Moorefield, Medicine Creek Watershed, Nebr.

Date	Time	Maximum or minimum gage height	Gage height change		Storage	Storage change	
			Plus	Minus		Plus	Minus
		Feet	Feet	Feet	Acre-ft.	Acre-ft.	Acre-ft.
1954 water year:							
Oct. 1...	12:01 a.m.	[1] 6.00	----	----	0.16	----	----
Oct. 20...	3:00 p.m.	5.95	----	0.05	.16	----	0
Oct. 21...	3:00 p.m.	7.70	1.75	----	.43	0.27	----
Dec. 28...	4:45 p.m.	7.66	----	.04	.42	----	.01
Jan. 28...	--------	7.37	----	.29	.36	----	.06
Feb. 1...	6:30 p.m.	10.35	2.98	----	1.57	1.21	----
Feb. 2...	10:30 a.m.	10.27	----	.08	1.51	----	.06
Feb. 2...	7:00 p.m.	10.62	.35	----	1.79	.28	----
Feb. 3...	12:00 m.	10.54	----	.08	1.71	----	.08
Feb. 3...	8:00 p.m.	10.64	.10	----	1.81	.10	----
Feb. 4...	1:00 p.m.	10.48	----	.16	1.67	----	.14
Feb. 4...	6:00 p.m.	10.50	.02	----	1.69	.02	----
Mar. 2...	11:40 a.m.	6.65	----	3.85	.22	----	1.47
Apr. 2...	2:15 p.m.	5.86	----	.79	.15	----	.07
May 1...	6:00 a.m.	4.88	----	.98	.06	----	.09
May 1...	12:00 m.	5.24	.36	----	.09	.03	----
May 14...	10:00 p.m.	4.92	----	.32	.06	----	.03
May 14...	12:00 p.m.	11.30	6.38	----	2.47	2.41	----
May 15...	8:30 p.m.	10.85	----	.45	2	----	.47
May 16...	1:00 a.m.	12.12	1.27	----	3.64	1.64	----
May 17...	2:00 a.m.	11.59	----	.53	2.83	----	.81
May 17...	6:00 a.m.	12.05	.46	----	3.53	.70	----
June 1...	10:00 p.m.	9.35	----	2.70	.99	----	2.54
June 1...	12:00 p.m.	9.37	.02	----	1	.01	----
June 13...	5:00 p.m.	8.61	----	.76	.69	----	.31
June 13...	8:00 p.m.	10.87	2.26	----	2.02	1.38	----
June 29...	3:00 a.m.	9.48	----	1.39	1.06	----	.96
June 29...	5:00 a.m.	9.52	.04	----	1.08	.02	----
Aug. 8...	3:00 p.m.	7.61	----	1.91	.41	----	.67

TABLE 14.--Continued

Aug. 8... 9:00 p.m.	11.54	3.93	----	2.76	2.35	----
Aug. 13... 6:00 p.m.	10.20	----	1.34	1.46	----	1.30
Aug. 13... 9:00 p.m.	10.40	.20	----	1.61	.15	----
Aug. 17...10:30 p.m.	10.01	----	.39	1.34	----	.27
Aug. 18... 1:00 a.m.	12.63	2.62	----	4.54	3.20	----
Sept. 8... 3:00 p.m.	9.56	----	3.07	1.10	----	3.44
Sept. 8... 4:00 p.m.	9.57	.01	----	1.10	----	----
Sept.14... 7:00 p.m.	9.34	----	.23	.99	----	.11
Sept.14... 8:00 p.m.	9.36	.02	----	1	.01	----
Sept.15... 9:00 p.m.	9.32	----	.04	.98	----	.02
Sept.15...10:00 p.m.	9.34	.02	----	.99	.01	----
Oct. 1...12:01 a.m.	8.86	----	.48	.79	----	----
Total					13.74	13.11

TABLE 14.--Continued

1955 water year:

Oct. 1...12:01 a.m.	8.86	----	----	0.79	----	----
Oct. 7...12:30 a.m.	8.74	----	0.12	.75	----	0.04
Oct. 7... 9:00 a.m.	8.82	0.08	----	.78	0.03	----
Oct. 11... 2:00 a.m.	8.77	----	----	.76	----	.02
Oct. 11... 5:30 a.m.	8.79	.02	----	.77	.01	----
Oct. 25...10:00 a.m.	8.47	----	.32	.65	----	.12
Oct. 25...12:00 m.	8.50	.03	----	.66	.01	----
Nov. 26... 4:00 p.m.	8.01	----	.49	.51	----	.15
Feb. 18... 1:00 a.m.	9.15	1.14	----	.91	.40	----
Feb. 26... 7:00 p.m.	9.13	----	.02	.90	----	.01
Feb. 28... 1:00 a.m.	10.98	1.85	----	2.13	1.23	----
Apr. 12... 1:00 a.m.	7.79	----	3.19	.45	----	1.68
Apr. 12... 4:00 a.m.	7.89	.10	----	.48	.03	----
Apr. 23... 9:00 a.m.	6.38	----	1.51	.20	----	.28
Apr. 23... 3:00 p.m.	6.55	.17	----	.22	.02	----
May 17 ... 1:00 a.m.	5.97	----	.58	.16	----	.06
May 17 ...11:00 a.m.	8.19	2.22	----	.57	.41	----
May 25 ... 7:00 p.m.	7.99	----	.20	.51	----	.06
May 26 ... 1:00 p.m.	8.81	.82	----	.77	.26	----
June 10... 1:00 a.m.	8.40	----	.41	.63	----	.14
June 10... 3:00 p.m.	8.43	.03	----	.64	.01	----
June 15... 2:00 a.m.	8.30	----	.13	.60	----	.04
June 15... 5:00 p.m.	8.33	.03	----	.61	.01	----
June 27... 7:00 a.m.	8.01	----	.32	.51	----	.10
June 27... 9:00 a.m.	8.25	.24	----	.58	.07	----
July 21... 9:00 p.m.	7.50	----	.75	.39	----	.19
July 21...10:00 p.m.	7.52	.02	----	.39	0	----
Aug. 8... 9:00 p.m.	7.33	----	.19	.36	----	.03
Aug. 8...10:00 p.m.	7.52	.19	----	.39	.03	----
Sept.25...11:00 a.m.	6.92	----	.60	.27	----	.12
Sept.25... 1:00 p.m.	7.03	.11	----	.30	.03	----
Oct. 1... 1:00 a.m.	6.98	----	.05	.29	----	.01
Total -					2.55	3.05

1956 water year:

Oct. 1... 1:00 a.m.	[2] 6.98	----	----	0.29	----	----
Nov. 22... 1:45 p.m.	5.94	----	1.04	.15	----	0.14
Feb. 21... 5:00 a.m.	8.25	2.31	----	.58	0.43	----
Feb. 22...11:00 p.m.	8.23	----	.02	.57	----	.01
Feb. 23... 6:30 a.m.	8.37	.14	----	.62	.05	----
Apr. 3... 2:00 a.m.	6.56	----	1.81	.22	----	.40
Apr. 4... 3:00 p.m.	7.21	.65	----	.33	.11	----
Apr. 5...11:00 a.m.	6.87	----	.34	.26	----	.07
Apr. 5... 5:00 p.m.	6.93	.06	----	.28	.02	----
Apr. 6... 1:00 a.m.	6.88	----	.05	.27	----	.01
Apr. 6... 3:40 a.m.	6.95	.07	----	.28	.01	----
May 1... 3:00 a.m.	6.37	----	.58	.20	----	.08
May 1... 4:00 a.m.	6.38	.01	.20	0	----	----
May 26...10:00 p.m.	5.63	----	.75	.12	----	.08
May 27... 1:00 a.m.	9.50	3.87	----	1.07	.95	----
May 27...11:00 a.m.	9.46	----	.04	1.05	----	.02
May 27 ... 3:00 a.m.	9.52	.06	----	1.08	.03	----
June 16... 8:00 p.m.	8.62	----	.90	.70	----	.38
June 17... 1:00 a.m.	10.98	2.36	----	2.13	1.43	----
June 18... 2:00 a.m.	10.75	----	.23	1.90	----	.23
June 18... 4:00 a.m.	11.73	.98	----	3.02	1.12	----
June 20... 9:30 p.m.	10.58	----	1.15	1.75	----	1.27
June 20...12:00 p.m.	11.03	.45	----	2.18	.43	----
July 1... 5:00 a.m.	9.92	----	1.11	1.28	----	.90
July 1... 6:00 a.m.	9.93	.01	----	1.29	.01	----
July 4... 9:00 p.m.	9.77	----	.16	1.20	----	.09
July 4...10:30 p.m.	12.35	2.58	----	4.04	2.84	----
July 5... 3:00 p.m.	12.20	----	.15	3.78	----	.26
July 5... 3:35 a.m.	15.01	2.81	----	10.23	6.45	----
July 5... 4:00 a.m.	15.68	----	----	12.29	----	----
July 5... 7:30 a.m.	15.01	----	----	10.23	----	----
July 12... 5:30 p.m.	10.94	----	4.07	2.09	----	8.14
July 12... 8:00 p.m.	12.60	1.66	----	4.48	2.39	----
July 17...10:00 p.m.	11.33	----	1.27	2.51	----	1.97
July 18...12:30 a.m.	13.04	1.71	----	5.35	2.84	----
July 31... 7:20 p.m.	10.68	----	2.36	1.84	----	3.51
July 31...10:00 p.m.	11.22	.54	----	2.38	.54	----
Aug. 9...11:45 p.m.	10.32	----	.90	1.55	----	.83
Aug. 10... 1:00 a.m.	10.59	.27	----	1.76	.21	----
Aug. 16... 8:00 p.m.	10.15	----	.44	1.36	----	.40
Aug. 17... 3:00 a.m.	10.18	.03	----	1.45	.09	----
Aug. 17... 8:30 p.m.	10.16	----	.02	1.42	----	.03
Aug. 17...11:00 p.m.	10.35	.19	----	1.57	.15	----
Sept. 4...10:00 p.m.	9.49	----	.86	1.06	----	.51
Sept. 5... 2:00 a.m.	9.54	.05	----	1.09	.03	----
Oct. 1...12:01 a.m.	8.71	----	.83	.73	----	.36
Total -					20.13	19.69

TABLE 14.--Continued

1957 water year:

Oct. 1...12:01 a.m.	8.71	----	----	0.29	----	----
Oct. 24... 4:00 a.m.	8.19	----	0.52	.18	----	0.11
Oct. 25... 1:00 p.m.	8.22	0.03	----	.18	----	----
Mar. 22...12:00 p.m.	7.09	----	1.13	.02	----	.16
Mar. 27... 5:00 p.m.	7.35	.26	----	.04	0.02	----
Mar. 30... 4:00 p.m.	7.34	----	.01	.04	----	0
Apr. 4... [3]	7.57	.23	----	.06	.02	----
Apr. 22... 2:10 p.m.	7.37	----	.20	.04	----	.02
Apr. 22... 9:00 p.m.	10.40	3.03	----	.99	.95	----
Apr. 30...12:40 a.m.	9.97	----	.43	.74	----	.25
Apr. 30... 8:00 a.m.	9.99	.02	----	.76	.02	----
May 8... 6:00 p.m.	9.67	----	.32	.60	----	.16
May 9... 8:00 a.m.	10.04	.37	----	.78	.18	----
May 11...12:00 p.m.	9.98	----	.06	.75	----	.03
May 12... 9:00 a.m.	10.28	.30	----	.92	.17	----
May 13... 1:00 p.m.	10.25	----	.03	.90	----	.02
May 13... 5:20 p.m.	13.14	2.89	----	4.64	3.74	----
May 14...12:01 a.m.	13	----	.14	4.36	----	.28
May 14... 2:00 a.m.	13.04	.04	----	4.44	.08	----
May 16... 3:30 a.m.	12.24	----	.80	2.96	----	1.48
May 16...10:30 a.m.	14.26	2.02	----	7.08	4.12	----
May 16... 1:00 p.m.	14.21	----	.05	6.96	----	.12
May 16... 5:10 p.m.	15.01	.80	----	9.15	2.19	----
May 16... 6:00 p.m.	15.06	----	----	9.31	----	----
May 16... 8:10 p.m.	15.01	----	----	9.15	----	----
May 24 ... 8:40 p.m.	12.23	----	2.78	2.95	----	6.20
May 25... 1:00 a.m.	12.77	.54	----	3.92	.97	----
May 31... 1:30 p.m.	11.90	----	.87	2.46	----	1.46
May 31... 6:30 p.m.	12.10	.20	----	2.75	.29	----
June 15...11:40 p.m.	10.96	----	1.14	1.41	----	1.34
June 16... 6:00 a.m.	11	.04	----	1.45	.04	----
June 26...12:01 p.m.	10.46	----	.54	1.03	----	.42
June 26... 3:00 p.m.	10.61	.15	----	1.14	.11	----
June 26... 9:00 p.m.	10.60	----	.01	1.13	----	.01
June 27... 2:00 a.m.	11.96	1.36	----	2.54	1.41	----
June 27...12:45 p.m.	11.91	----	.05	2.47	----	.07
June 27... 3:00 p.m.	13.38	1.47	----	5.12	2.65	----
July 7... 9:30 p.m.	11.83	----	1.55	2.37	----	2.75
July 7...11:30 p.m.	11.88	.05	----	2.43	.06	----
July 14... 3:00 a.m.	11.48	----	.40	1.94	----	.49

July 14... 9:00 a.m.	11.51	.03	----	1.97	.03	----
July 18... 9:00 p.m.	11.25	----	.26	1.69	----	.28
July 18...10:00 p.m.	11.28	.03	----	1.72	.03	----
July 20...10:00 p.m.	11.21	----	.07	1.65	----	.07
July 21... 5:00 p.m.	11.23	.02	----	1.67	.02	----
July 21...12:50 p.m.	11.21	----	.02	1.65	----	.02
July 21... 3:30 p.m.	12.42	1.21	----	3.27	1.62	----
Aug. 7... 5:30 p.m.	11.31	----	1.11	1.75	----	1.52
Aug. 7...10:40 p.m.	11.36	.05	----	1.81	.06	----
Aug. 27... 8:40 p.m.	10.60	----	.76	1.13	----	.68
Aug. 27...11:00 p.m.	11.75	1.15	----	2.26	1.13	----
Sept. 9... 4:30 a.m.	11.25	----	.50	1.69	----	.57
Sept. 9...10:00 a.m.	11.29	.04	----	1.73	.04	----
Sept.13... 3:00 a.m.	11.20	----	.09	1.64	----	.09
Sept.13... 6:00 p.m.	11.84	.64	----	2.38	.74	----
Oct. 1...12:01 a.m.	11.70	----	.14	2.20	----	.18
Total -					20.69	18.78

TABLE 14.--Continued

1958 water year:						
Oct. 1...12:01 a.m.	11.70	----	----	2.20	----	----
Oct. 7... 5:00 a.m.	11.46	----	0.24	1.92	----	0.28
Oct. 7... 2:00 p.m.	11.47	0.01	----	1.93	0.01	----
Oct. 13... 8:00 a.m.	11.38	----	.09	1.83	----	.10
Oct. 13... 6:00 p.m.	11.42	.04	----	1.87	.04	----
Oct. 19... 3:00 a.m.	11.34	----	.08	1.78	----	.09
Oct. 20... 8:00 a.m.	11.46	.12	----	1.92	.14	----
Feb. 21...12:00 m.	10.24	----	1.22	.89	----	1.03
Feb. 21... 6:00 p.m.	10.41	.17	----	1	.11	----
Feb. 26... 9:00 a.m.	10.40	----	.01	.99	----	.01
Feb. 28...12:00 m.	10.64	.24	----	1.16	.17	----
Mar. 24... 2:00 p.m.	10.42	----	.22	1	----	.16
Mar. 30...12:00 m.	13	2.58	----	4.36	3.36	----
Apr. 22... 8:00 p.m.	10.54	----	2.46	1.09	----	3.27
Apr. 23...11:00 a.m.	10.82	.28	----	1.30	.21	----
Apr. 26...12:30 a.m.	10.77	----	.05	1.26	----	.04
Apr. 27...12:00 p.m.	11.11	.34	----	1.55	.29	----
May 12... 9:00 p.m.	10.74	----	.37	1.23	----	.32
May 14...12:00 m.	11.10	.36	----	1.54	.31	----
May 27... 1:00 a.m.	10.85	----	.25	1.32	----	.22
May 27 ... 2:00 a.m.	10.87	.02	----	1.34	.02	----
June 11...11:00 p.m.	10.49	----	.38	1.05	----	.29
June 12... 5:00 a.m.	13.95	3.46	----	6.34	5.29	----
June 18... 8:00 p.m.	12.63	----	1.32	3.66	----	2.68
June 18...11:30 p.m.	13.10	.47	----	4.56	.90	----
July 3... 4:00 a.m.	11.97	----	1.13	2.56	----	2
July 4...11:00 a.m.	12.02	.05	----	2,63	.07	----
July 10... 4:30 a.m.	11.78	----	.24	2.30	----	.33
July 10... 5:00 a.m.	11.80	.02	----	2.33	.03	----
July 12... 8:00 a.m.	11.75	----	.05	2.26	----	.07
July 12...11:00 a.m.	11.87	.12	----	2.42	.16	----
July 16... 4:00 a.m.	11.75	----	.12	2.26	----	.16
July 16... 7:30 a.m.	11.79	.04	----	2.32	.06	----
July 18... 9:00 p.m.	11.70	----	.09	2.20	----	.12
July 19... 1:00 a.m.	12.36	.66	----	3.16	.96	----

TABLE 14.--Continued

July 20... 7:00 p.m.	12.28	----	.08	3.03	----	.13
July 20...11:30 p.m.	13.32	1.04	----	5	1.97	----
July 30... 9:00 p.m.	12.34	----	.98	3.13	----	1.87
July 30... 9:00 p.m.	12.36	.02	----	3.16	.03	----
Aug. 21...12:00 p.m.	11.63	----	.73	2.12	----	1.04
Aug. 22... 2:00 a.m.	11.66	.03	----	2.15	.03	----
Sept.13... 5:00 p.m.	11.10	----	.56	1.54	----	.61
Sept.14... 3:00 a.m.	11.35	.25	----	1.80	.26	----
Sept.19... 7:00 a.m.	11.24	----	.11	1.68	----	.12
Sept.19... 1:00 p.m.	11.34	.10	----	1.78	.10	----
Oct. 1...12:01 a.m.	11.12	----	.22	1.56	----	.22
Total					14.52	15.16

1/ Estimated.
2/ Poor gage height.
3/ From weather records.

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOIL AND WATER CONSERVATION RESEARCH DIVISION

RESERVOIR SEDIMENTATION DATA SUMMARY

TABLE 15.--
Reservoir Sedimentation Data
Summary Runoff - Dempcy Pond
Medicine Creek Watershed - Nebraska
NAME OF RESERVOIR

33-7
DATA SHEET NO.

DAM	1. OWNER Bruce Dempcy	2. RIVER Unnamed tributary to East Curtis Creek	3. STATE Nebraska
	4. LONG. Sec. 6 LAT. T-9N RANGE R27W	5. NEAREST TOWN Moorefield	6. COUNTY Lincoln
	7. STREAM BED ELEV.	8. TOP OF DAM ELEV. 104.0 *	9. SPILLWAY CREST ELEV. *100.0

	10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. SURFACE AREA ACRES	13. STORAGE ACRE-FEET	14. ACCUMULATED ACRE-FEET	15. DATE STORAGE BEGAN
RESERVOIR	a. FLOOD CONTROL					
	b. POWER					June 1949
	c. WATER SUPPLY					16. DATE NORMAL OPER. BEGAN
	d. IRRIGATION					
	e. CONSERVATION	100.0		11.00	11.00	
	f. INACTIVE					June 1949
	17. LENGTH OF RESERVOIR 0.12[1/] MILES			AV. WIDTH OF RESERVOIR 99 FEET		

WATERSHED	18. TOTAL DRAINAGE AREA 0.516 SQ. MI.		22. MEAN ANNUAL PRECIPITATION 21.5(60 yr) INCHES	
	19. NET SEDIMENT CONTRIBUTING AREA 0.51 SQ. MI.		23. MEAN ANNUAL RUNOFF INCHES	
	20. LENGTH MILES	AV. WIDTH MILES	24. MEAN ANNUAL RUNOFF AC.-FT.	
	21. MAX. ELEV.	MIN. ELEV.	25. CLIMATIC CLASSIFICATION Sub-humid	

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA ACRES	32. CAPACITY ACRE-FEET	33. C/W RATIO AC.-FT. PER SQ. MI.
June 1949						11.00	21.31
July24,1953	4.0		Detailed Range	13	2.88	10.10	19.57
June10,1958	4.9	8.9	"	16	2.78	9.12	17.67

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW ACRE-FEET			36. WATER INFL. TO DATE AC.-FT.	
		a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	a. MEAN ANNUAL	b. TOTAL TO DATE
July24,1953	19.9					
June10,1958	17.0	15.08	23.51	65.52		

26. DATE OF SURVEY	37. PERIOD SEDIMENT DEPOSITS ACRE-FEET			38. TOTAL SED. DEPOSITS TO DATE ACRE-FEET		
	a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR
July24,1953	0.90	0.225	0.441	0.90	0.225	0.441
June10,1958	0.98	0.200	0.392	1.88	0.211	0.414

26. DATE OF SURVEY	39. AV. DRY WGT. LBS. PER CU. FT.	40. SED. DEP. TONS PER SQ. MI.-YR.		41. STORAGE LOSS PCT.		42. SED. INFLOW PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANNUAL	b. TOT. TO DATE	a. PERIOD	b. TOT. TO DATE
July24,1953				2.05	8.18		
June10,1958	75.6(16)	645	1363	1.92	17.09	18,120	

SWC Form 30
Apr 1958

TABLE 15.--Continued

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET ABOVE, AND BELOW, CREST ELEVATION											
				115-85	8.5-8	8-6	6-4	4-2	2-0			
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											
	There is no contour map for 1949 survey.											
Sed. accumulation between 1953 & 1958				12.30	5.89	17.22	34.14	16.20	14.25			

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGH OF RESERVOIR														
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW AC.-FT.	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW AC.-FT.

46. ELEVATION—AREA—CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
91.5	0	0	104.0	4.508	23.518			
92.0	.063	0.011						
94.0	.338	0.376						
95.5	.589	1.062						
96.0	.965	1.447						
98.0	2.007	4.356						
100.0	2.782	9.124						
102.0	3.569	15.459						

47. REMARKS AND REFERENCES 1/Reservoir consists of two arms, both 0.12 miles in length.

1953 Survey was made by Soil Conservation Service and Geological Survey personnel.
1958 Survey conducted by Agricultural Research Service, Lincoln, Nebraska

USDA Agricultural Research Service
Soil and Water Conservation Research Division
Hastings, Nebraska 68901

48. AGENCY SUPPLYING DATA

49. DATE Jan. 10, 1962

TABLE 16.-- Erosion survey data, Dry Creek channel, Medicine Creek Watershed, Nebr.

Item No.	[1] Station distances			Cross sectional intervals	Survey dates		Location	
	From (Downstream)	To (Upstream)	Primary Cross section	Downstream and upstream from primary section	Original	Subsequent	Feature	Description
	Feet	Feet	Feet	Feet				
1	47,830	49,830	48,830	50	June 4-13, 1951	May 2-12, 1952 Mar. 19-23, 1956	Main Channel	S. 29, T 9 N, R 27 W
2-1	—	—	50,650	—	May 16, 1951	May 16, 1951	----do----	S. 29, T 9 N, R 27 W
2-2	—	—	51,660	—	May 16, 1951	Apr. 29, 1952	----do----	S. 20, T 9 N, R 27 W
2-3	—	—	53,540	—	May 28, 1951	Apr. 28, 1952	----do----	S. 20, T 9 N, R 27 W
2-4	—	—	55,355	—	May 28, 1951	Apr. 25, 1952	----do----	S. 20, T 9 N, R 27 W
3	1,840	3,840	2,840	50	June 4-13, 1951	May 26-June 6, 1952 1960 Mar. 26-Apr. 17, 1956	East Fork	S. 32, T 9 N, R 27 W
3-A	400	1,000	700	100	Dec. 2, 1953 - Jan. 21,22, 1954	Apr. 18-19, 1956 Sept. 3, 1960	----do----	S. 32, T 9 N, R 27 W
4-1	—	—	5,000	—	May 18, 1951	May 21, 1952	----do----	S. 32, T 9 N, R 27 W
4-2	—	—	5,930		May 21, 1951	May 21, 1952	----do----	S. 29, T 9 N, R 27 W
5	823	2,823	1,823	50	June 13, 1951	June 10-16, 1952 Apr. 24-26, 1956	East Branch	S. 6, T 8 N, R 27 W
6-1	—	—	4,300	50	May 22, 1951	June 3, 1952	----do----	S. 5, T 8 N, R 27 W
6-2	—	—	4,230	—	May 22, 1951	June 3, 1952	----do----	S. 6, T 8 N, R 27 W
7	17,920	18,520	18,220	50	May 22, 1951	May 22, 1952	Main Channel	S. 24, T 8 N, R 28 W
8-A	24,165	24,765	24,465	50	May 23, 1951	June 6 & 9, 1952	----do----	S. 13, T 8 N, R 28 W
8-B	30,180	30,780	30,480	50	May 24, 1951	Apr. 23, 1952	----do----	S. 7, T 8 N, R 27 W
8-C	35,065	35,665	35,365	50	May 29, 1951	June 4-5, 1952	----do----	S. 6, T 8 N, R 27 W
8-D	38,400	39,000	38,700	50	May 25, 1951	May 20, 1952	----do----	S. 6, T 8 N, R 27 W
8-E	43,610	44,210	43,910	50	May 28, 1951	May 14-15, 1952	----do----	S. 32, T 9 N, R 27 W
8-F	44,950	46,150	45,150	50	Nov. 16-25, 1953	-	----do----	S. 32, T 9 N, R 27 W
9-1	—	—	59,045	—	May 28, 1951	Apr. 25, 1952	----do----	S. 27, T 9 N, R 27 W
9-2	—	—	16,020	—	May 28, 1951	May 21, 1952	East Fork	S. 21, T 9 N, R 27 W
10	[2] 1,370	[2] 1,970	1,870	100	May 22, 1951	June , 1952 Nov. 30, 1953[2]	West Branch	S. 6, T 8 N, R 27 W
10-A	216		316	[4] 100	Dec. 1, 1953	-	----do----	S. 6, T 8 N, R 27 W
10-B	[3] 575	[3] 1,175	[3] 925	50	May 1-3, 1956	-	West Fork of West Branch	S. 1, T 8 N, R 28 W

[1] Station distances are measured from south of Dry Creek or tributary.
[2] Cross sections upstream were established in 1953; 500 ft. downstream upstream and 100 ft. at 100 ft. intervals.
[3] Approximate.
[4] Upstream only.

TABLE 17.--Particle size analysis, Dry Creek Channel soil samples, Medicine Creek Watershed, Nebr.

Sample No.	Screen size No. (percent passing)							Particle diameter (mm) (percent passing)					1/ Sand	2/ Silt	3/ Clay
	4	8	16	30	50	100	200	0.050	0.037	0.019	0.009	0.005			
1	100	100	99.9	99.8	99.7	99.6	98.7	86.1	74.2	50.7	35.9	28.4	1.3	70.3	28.4
2	100	99.8	99.6	99.3	98.6	97	94.3	81.3	70.9	41.7	23.4	16.2	5.7	78.1	16.2
3	100	99.9	99.8	99.6	99.2	98.8	97.3	86.6	76.5	52.5	34.1	29.8	2.7	67.5	29.8
4	100	100	99.9	99.8	99.7	99.5	96.9	82.2	67.1	36	23.3	16.9	3.1	80	16.9
5	100	100	99.9	99.9	99.6	99.1	96.9	86.6	77.7	50.4	33.5	24.4	3.1	72.5	24.4
6	100	99.9	99.8	99.6	99.5	98.6	94	81.4	67.3	38.2	23.5	16.2	6	77.8	16.2
7	100	99.9	99.8	99.8	99.5	99.3	97	80.7	65.2	32	18.4	15.9	3	81.1	15.9
8	100	100	99.9	99.8	99.4	98.6	96.6	89.6	79	56.8	39	29.9	3.4	66.7	29.9
9	100	100	100	100	99.9	99.9	99.5	85.2	82.2	60.3	40.8	28.5	.5	71	28.5
10	100	100	100	99.8	99.3	98.5	96.7	87.4	75.8	47.4	31.1	24.2	3.3	72.5	24.2
11	100	99.8	99.7	99.6	99	95.6	94.2	82.3	75.7	55.4	37.7	28.4	5.8	65.8	28.4
12	100	100	99.9	99.8	99.7	99.6	98.4	89.9	81.1	57.5	40.1	27.6	1.6	70.8	27.6
13	100	100	99.6	98.2	95.4	92.5	90.7	79.6	77.8	61.7	48.1	34.3	9.3	56.4	34.3
14	100	100	99.8	99.7	99.6	99.3	95.3	79.7	66.3	38.7	25.2	18.5	4.7	76.8	18.5
15	100	99.9	99.9	99.8	99.4	98.8	95.8	84.3	74.7	48.6	31.6	23.6	4.2	72.2	23.6
16	100	99.9	99.8	99.6	99.2	98.8	93.7	78.1	63.2	35	21.6	16.1	6.3	77.6	16.1
17	100	100	99.8	99.8	99.4	98.9	97.7	86.6	77.8	52.4	30.7	20.5	2.3	77.2	20.5
18	100	100	99.8	99.6	98.7	97.7	95.1	79.1	64.9	31.6	18.6	15.8	4.9	79.3	15.8
19	100	100	99.9	99.9	99.9	99.8	96.7	80.5	67.9	39.3	25.1	18.4	3.3	78.3	18.4
20	100	100	99.9	99.8	99.7	99.6	96.6	89.3	81.5	59.3	41.5	30.9	3.4	65.7	30.9
21	100	100.0	99.9	99.9	99.8	99.8	99.3	87.7	73.9	46.4	27.1	20.6	1.7	77.7	20.6
22	100	99.3	97.9	96	91.4	87.9	83.5	76	67.1	44.3	26.6	18.4	16.5	65.1	18.4
23	100	100	99.9	99.8	99.7	99.6	98.3	84.9	76.1	51.5	34	23.8	1.7	74.5	23.8
24	100	100	100	100.	99.9	99.8	98.3	86.7	78.8	48	28.7	20.1	1.7	78.2	20.1
25	100	100	100	99.3	99.9	99.8	98.9	89	77.1	50.4	34.6	25.7	1.1	73.2	25.7
26	100	100	100	99.9	99.2	98.3	96	83.5	73	43.8	26.3	20.6	4	75.5	20.5
27	100	100	99.9	99.7	99.6	99.4	97.7	86	77.2	43	22.3	16.8	2.3	70.9	16.8
28	100	100	99.9	99.9	99.8	99.7	98.1	81.2	76.3	25.7	15.1	12.1	1.9	86.	12.1
29	100	100	100	99.8	99.5	98.7	95.1	85.4	73.9	41.4	23.9	16.4	4.5	79.1	16.4
30	100	99.9	99.8	99.7	99.3	99.1	97.3	84.1	73.4	43.8	28.6	22.6	2.7	74.7	22.6
31	100	100	99.9	99.9	99.8	99.6	94.1	81.5	70.2	44.4	30.7	22	5.9	72.1	22
32	100	100	100	99.8	99.7	99.5	91.2	76.8	62.2	29.4	19.2	14.2	8.8	77	14.2
33	99	98.7	98.4	98.3	98.2	98	91.7	71.9	56.3	31.5	21.1	17.6	8.3	74.1	17.6
34	100	100	99.9	99.8	99.7	99.6	98.1	81.8	74	43.8	25.7	17.1	1.9	81	17.1
35	100	100	100	100	100.	100	96.4	78.6	60.7	31.2	21.8	18.9	3.6	77.5	18.9

TABLE 17.--Continued

36	100	100	100	100	99.8	99.5	94.2	82.7	73.3	47.7	29.6	20.5	5.8	73.7	20.5
37	100	100	100	100	99.9	99.3	97.8	80.2	67.1	34.8	22.9	18	2.2	79.8	18
38	100	100	99.9	99.8	99.5	99	91.5	80.5	68.6	46.3	32.8	26.5	8.5	65	26.5
39	100	99.9	99.4	97.4	95.6	93	90	79.2	73.8	32.4	29.5	19.3	10	70.7	19.3
40	100	100	99.9	99.9	99.8	99.7	95.9	80.6	66.2	37.8	22.4	18.0	4.1	77.9	18
41	100	99.9	99.5	99.1	98.6	98.1	89	70	65.9	29	19	15.3	11	73.7	15.3
42	100	100	100	99.9	99.6	99.1	95.9	84.8	71.6	40.7	25.8	17.8	4.5	77.7	17.8
43	100	100	100	99.9	99.7	99.5	96.3	81.7	63.4	34.3	19.5	18.5	3.7	77.8	18.5
44	100	100	100	100	99.8	99.7	95.7	76.9	61.6	35.8	21.8	15.5	4.3	80.2	15.5
45	100	100	99.9	99.8	99.7	99.6	91.9	71.1	53.5	26.5	18.2	14.7	8.7	77.2	14.7
46	100	100	99.9	99.8	99.6	99	86.9	67.4	48.3	22.9	14.1	10.9	13.1	76	10.9
47	99.9	99.9	99.8	99.5	98.9	98.2	95.2	85.5	66.1	48.2	30.3	23.4	4.8	71.8	23.4
48	100	100	99.8	99.6	99.1	98.5	91.6	79.5	64.7	37.7	23.1	19.1	8.4	72.5	19.1
49	100	100	99.7	99.3	98.7	97.9	94	79.1	65	35	21.8	15.2	6	78.8	15.2
50	100	99.9	99.8	99.6	99.4	99	94.2	80.1	66.9	38.6	22.4	18.8	5.8	75.4	18.8
51	98.4	98.3	97.9	96.1	93.6	91.6	86.2	80.5	69.6	43.8	26.2	20.5	13.8	65.7	20.5
52	100	100	100	100	100	100	97.1	78.3	56.9	24.7	15.1	11.1	2.9	86	11.1
53	100	100	100	99.9	99.8	99.5	95.1	79.9	70.4	39	26.1	18.6	4.9	76.5	18.6
54	100	99.9	99.8	99.5	98.4	94.8	83.8	71.7	60.8	38.2	25.8	18.9	16.2	64.9	18.9
55	100	99.7	99.6	99.5	99.4	99.8	91.8	71.8	54	22.2	16.2	13.6	8.2	78.2	13.6
56	100	100	99.9	99.9	99.6	99.2	97.5	79	70.7	40.1	20.4	14.6	2.5	82.9	14.6
57	100	100	100	100	99.9	99.5	98.8	82	64.2	29.6	17.4	12.6	1.2	86.2	12.6
58	100	100	100	100	99.9	99.7	94.1	80.2	62.3	29	16.9	13.6	5.9	80.5	13.6
59	100	100	100	99.9	99.8	99.7	98.4	83	80.7	43.9	23.4	16.5	1.6	81.9	16.5
60	100	100	100	99.8	99.4	98.8	93.8	78.8	62.8	32.8	19.3	13.5	6.2	80.3	13.5
61	100	100	100	99.9	99.9	99.2	81.3	66	52.2	30.2	22.1	17.1	18.7	64.2	17.1
62	100	100	100	99.9	99.8	99.5	95.7	81.9	67.6	36.9	23.4	17.4	4.3	78.3	17.4

1/ Sand

	Percent	Sample No.
Maximum----	18.7	61
Minimum----	.5	9
Average----	5.35	

2/ Silt

	Percent	Sample No.
Maximum----	86.2	57
Minimum----	56.4	13
Average----	75.12	

3/ Clay

	Percent	Sample No.
Maximum----	34.3	13
Minimum----	10.9	46
Average----	19.53	

TABLE 18.--Volume weight determinations of Dry Creek channel soil samples, Medicine Creek Watershed, Nebr.
(Samples 1 to 16 taken 6-9-53, samples 17 to 42 taken 6-10-53, samples 43 to 62 taken 6-11-53)

Sample No.	Item No.	Sample length	Sample volume	Sample dry weight	Dry density 1/	Sampler 2/	Remarks
		Cm.	C.c.	Grams	Lb./c.f.		
1	9-1	61	173.86	182.05	65.3	King	Small channel bottom; near surface sample; considerable cover.
2	9-1	-	407	524.85	80.5	Biscuit	Flat over bank; approx. 50 ft. from center range.
3	2-4	62.9	179.28	219.60	76.4	King	Small channel bottom; no apparent cutting; approx. 75 ft. from center range.
4	2-4	-	407	522.05	80	Biscuit	Near-surface sample from small flat over bank; alfalfa bottom; approx. 100 ft. from center range.
5	2-3	61.2	174.43	219.10	78.4	King	75 ft. from center range right channel; considerable cover.
6	2-3	-	407	399.10	61.2	Biscuit	Near-surface sample from small flat over bank in alfalfa field.
7	2-2	61.7	175.86	223.70	79.4	King	On grass flat flood plain.
8	2-2	-	407	498.20	76.4	Biscuit	Small channel within listed cornfield; 8 in. below bottom of channel.
9	1	65.2	185.83	210.30	70.6	King	36 in. below top of head cut in vertical bank.
10	1	63.1	179.85	240.85	83.6	--do--	9 ft. below top of head cut in vertical bank.
11	1	65.4	186.40	193.25	64.7	--do--	Center of channel bottom.
12	-	61.9	176.43	231.25	81.8	--do--	250 ft. upstream from item 1 in vertical bank of head cut; 13.5 ft. below surface.
13	-	63	179.56	199.50	69.3	--do--	250 ft. upstream from item 1; 5 ft. below surface in vertical bank.
14	2-1	74.3	211.77	236.90	69.8	--do--	On flat flood plain; approx. 100 ft. from center range in wheatfield.
15	2-1	59.8	170.44	205.55	75.2	--do--	Shallow drain; approx. 125 ft. from centerline.
16	-	-	407	536.80	82.3	Biscuit	400 ft. above item 1 on flood plain; near-surface sample.
17	9-2	-	407	416.30	63.8	--do--	2½ ft. below surface within vertical bank of 4 ft. deep channel.
18	9-2	63.1	179.85	209.65	72.7	King	Bottom of 4 ft. deep channel.
19	9-2	62.4	177.85	247.80	86.9	--do--	10 ft. left of top of ditch on grass covered flood plain; near-surface sample.
20	4-2	62	176.71	201.75	71.3	--do--	Bottom of 18 in. deep V-shaped channel. Heavy cover of sweetclover on flat.
21	4-2	-	407	465.40	71.3	Biscuit	Flat flood plain with heavy cover; approx. centerline of section, near surface sample.
22	4-1	-	407	457.50	70.1	--do--	Flat flood plain, 75 ft. from center range, near-surface sample.
23	4-1	61.1	174.15	198.55	71.1	King	6 in. flat channel with considerable cover.
24	3	65.8	187.54	210.60	70.1	--do--	Driven vertically 1 ft. below surface of right bank.
25	3	60.5	172.44	243.90	88.2	--do--	Driven horizontally 8 ft. below surface in vertical bank.
26	3	63.1	179.85	206.50	71.6	--do--	19 ft. below surface in vertical bank.
27	-	64.3	183.27	229.55	78.1	--do--	14 ft. below top of left bank in head cut, 350 ft. above item 3.
28	-	64.8	184.69	241.20	81.5	--do--	In headcut 350 ft. above item 3, 10 ft. below surface of left bank.
29	-	62.6	178.42	211.50	73.9	--do--	350 ft. above item 3, vertical distance 8 in. below surface at extreme head cut.
30	-	-	407	465.20	71.3	Biscuit	1,000 ft. above item 3, near surface sample from side slope of channel 3 ft. deep.

TABLE 18.--Continued

31	8-E	60.8	173.29	246.30	88.7	King	Vertical distance 8 in. below surface-grass covering in bottom.
32	8-E	63.6	181.27	246.40	84.8	--do--	Driven horizontally 6 ft. below top of bank.
33	8-E	60.8	173.29	242.40	87.3	--do--	Driven horizontally 9½ ft. below top of bank.
34	5	63.1	179.85	212.30	73.6	--do--	1 ft. below top of bank.
35	-	64	182.41	216.60	74.1	--do--	375 ft. above item 5 12 ft. below top of bank at extreme head cut.
36	5	64.4	183.55	233.95	79.6	--do--	11 ft. below terrace level in right vertical bank.
37	5	63.7	181.56	230.90	79.4	--do--	18 ft. below terrace level in left bank.
38	-	68.5	195.24	304.45	97.3	--do--	200 ft. above item 5 on secondary tributary; 17 ft. below top of bank at extreme head cut.
39	-	-	407	417.15	64	Biscuit	450 ft. above item 5; near-surface sample on right bank 75 ft. above head cut.
40	8-D	65.9	187.83	214.70	71.3	King	Near top of left bank.
41	8-D	60.9	173.58	230.50	82.7	--do--	Bottom of 12 in. channel which is eroding slightly.
42	8-D	62.6	178.42	223.35	78.1	--do--	9½ ft. below surface of right bank.
43	10	63.3	180.42	200.90	69.5	--do--	Driven vertically 1 ft. below top of left bank 300 ft. downstream from large stock dam.
44	10	63.2	180.13	218.45	75.7	--do--	7½ ft. below top of left bank.
45	10	63.4	180.70	237.20	81.9	--do--	16½ ft. below top of right bank.
46	10	-	407	537.95	82.5	Biscuit	100 ft. above item 10;12in. below surface of left bank of 5 ft. channel.
47	6-1	60.4	172.15	213.85	77.5	King	Bottom of 4 ft. U-shaped channel.
48	6-1	-	407	546.25	83.7	Biscuit	Near-surface sample 10 ft. from left bank.
49	6-2	62	176.71	237.20	83.8	King	Should compare favorably with sample 50; bottom of valley eroded slightly.
50	6-2	-	407	575.95	88.3	Biscuit	Near-surface elevation at centerline of item; flat flood plain with some cover.
51	8-C	61.9	176.43	204.20	72.2	King	Bottom of channel - eroding slightly.
52	8-C	65.7	187.26	252.85	84.3	--do--	11 ft. below top of left bank.
53	8-C	64.7	184.41	240.85	81.5	--do--	4 ft. below top of left bank.
54	8-C	-	407	455.30	69.8	Biscuit	Near-surface sample on left bank.
55	7	55	156.76	211.60	84.2	King	Driven vertically 1 ft. below right bank; 8 ft. to Ogallala formation from top of bank.
56	7	62.9	179.28	216.40	75.3	--do--	7½ ft. below top of right bank.
57	8-A	64.1	182.70	205.15	70.1	--do--	1 ft. below top of right bank driven vertically.
58	8-A	62.7	178.71	231.60	80.9	--do--	14 ft. below top of right bank.
59	8-A	65	185.26	230.85	77.5	--do--	7 ft. below top of right bank.
60	8-B	63.8	181.84	207.90	71.3	--do--	Near top of left bank.
61	8-B	62.7	178.71	237.55	82.9	--do--	4 ft. below top of right bank.
62	8-B	61.7	175.86	228.25	81	--do--	9½ ft. below top of left bank.

1/ Dry Density	lbs./ft.^{3}	Sample No.
Maximum	97.3	38
Minimum	61.2	6
Average	76.96	

2/ King	lbs./ft.^{3}	Sample No.
Maximum	97.3	38
Minimum	64.7	11
Average	77.6	

Biscuit	lbs./ft.^{3}	Sample No.
Maximum	88.3	50
Minimum	61.2	6
Average	74.7	

TABLE 19.--

Harry Strunk Lake
(Medicine Creek Dam)
NAME OF RESERVOIR

33-2
DATA SHEET NO.

RESERVOIR SEDIMENTATION DATA SUMMARY

DAM	1. OWNER Bureau of Reclamation	2 RIVER Medicine Creek	3. STATE Nebraska
	4 LONG. - LAT 5-6N RANGE 25-26W	5. NEAREST TOWN Cambridge	6. COUNTY Frontier
	7. STREAM BED ELEV. 2,300	8 TOP OF DAM ELEV. 2,415	9. SPILLWAY CREST ELEV. 2,386.2

RESERVOIR	10. STORAGE ALLOCATION	11 ELEVATION TOP OF POOL	12 SURFACE AREA ACRES	13. STORAGE ACRE-FEET	14. ACCUMULATED ACRE-FEET	15. DATE STORAGE BEGAN
	a. FLOOD CONTROL	2,386.2	3,550	52,320	92,817	8-8-49[a]
	b. POWER					
	c. WATER SUPPLY					16. DATE NORMAL OPER. BEGAN
	d. IRRIGATION	2,366.1	1,897	34,531	40,497	
	e. CONSERVATION					
	f. INACTIVE	2,335.0	520	5,966	5,966	8-8-49
	17. LENGTH OF RESERVOIR 8.5[b] MILES			AV. WIDTH OF RESERVOIR 1800 FEET		

WATERSHED	18. TOTAL DRAINAGE AREA 656 SQ. MI.		22. MEAN ANNUAL PRECIPITATION 19.37 INCHES
	19 NET SEDIMENT CONTRIBUTING AREA 653 SQ. MI.		23. MEAN ANNUAL RUNOFF - INCHES
	20. LENGTH 47 MILES	AV. WIDTH 14 MILES	24 MEAN ANNUAL RUNOFF 54,892 AC.-FT.
	21. MAX. ELEV. +3100	MIN. ELEV. 2300	25. CLIMATIC CLASSIFICATION Sub-humid

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28 ACCL. YEARS	29 TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA ACRES	32. CAPACITY ACRE-FEET	33. C/W RATIO AC.-FT. PER SQ.MI.
Aug. 8,1949	0	0	Contour	10 ft.	3,550	92,817	141.5
Oct. 4,1951	2.16	2.16	Rnge (D)	34	3,457	90,920	138.6
Dec. 8,1962	11.17	13.33	Rnge (D)	31	3,427	88,663	135.2

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW ACRE-FEET			36. WATER INFL. TO DATE AC-FT.	
		a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	a. MEAN ANNUAL	b. TOTAL TO DATE
Oct. 4,1951	25.56	71,456	99,040	154,344	71,456	154,344
Dec. 8,1962	18.48	51,690	99,040	577,374	54,892	731,718

26. DATE OF SURVEY	37. PERIOD SEDIMENT DEPOSITS ACRE-FEET			38. TOTAL SED. DEPOSITS TO DATE ACRE-FEET		
	a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ.MI.-YEAR	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ.MI.-YEAR
Oct. 4,1951	1,370	634	0.97	1,370	634	0.97
Dec. 8,1962	2,983	267	0.24	4,353	326	0.50

26. DATE OF SURVEY	39. AV. DRY WGT. LBS. PER CU. FT.	40. SED. DEP. TONS PER SQ.MI.-YR.		41. STORAGE LOSS PCT.		42. SED. INFLOW PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANNUAL	b. TOT. TO DATE	a. PERIOD	b. TOT. TO DATE
Oct. 4,1951	71.4	1,508	1,508	0.683	1.48	15,651	15,651
Dec. 8,1962	70.3	622	766	0.351	4.69	5,820	6,702

TABLE 19.--Continued

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET ABOVE, AND BELOW, CREST ELEVATION											
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											
Oct.4,1951 Dec.8,1962	3.1	10.6	8.2	11.2	22.2	20.9	14.8	7.5	0.11	0.07	0.16	1.1

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGH OF RESERVOIR														
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														
Oct.4,1951 Dec.8,1962	6	3	2	7	13	19	24	12	10	4					

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW AC.-FT.	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW AC.-FT.
1950	2,362.55	2,329.30	49,153[c]	1958	2,367.90	2,363.70	48,113
1951	2,372.35	2,362.50	99,040	1959	2,367.35	2.354.75	40,727
1952	2,367.40	2,364.00	43,371	1960	2,374.10	2,353.27	75,420
1953	2,366.50	2,357.30	38,171	1961	2,367.96	2,354.03	39,563
1954	2,366.10	2,354.05	40,481	1962	2,372.90	2,356.81	99,040
1955	2,369.20	2,347.45	38,498				
1956	2,363.60	2,348.25	40,444				
1957	2,371.90	2,352.50	66,340				

46. ELEVATION-AREA-CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
2312.0	0	0	2370.0	2,113	44,889			
2320.0	118	472	2380.0	2,854	69,725			
2330.0	352	2,822	2386.2	3,427	88,663			
2340.0	605	7,607						
2350.0	924	15,254						
2360.0	1,445	27,098						
2366.1	1,833	36,989						

47. REMARKS AND REFERENCES

[a] Closure made at 9:00 a.m. on August 8, 1949

[b] At normal water surface elevation, 2366.1

[c] Estimate

48. AGENCY SUPPLYING DATA (Bureau of Reclamation)

49. DATE________________

TABLE 20.--Land use summary, Medicine Creek Watershed, Nebr., 1954

Subwatershed	Row crop	Small grain	Fallow	Hay	Pasture or range	Subtotal	Farmsteads	Roads	Streams and lakes	Trees	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
A- - -	53,927	27,339	37,151	23,972	288,872	431,261	1,971	5,293	4,020	274	442,819
B- - -	49,491	25,580	35,421	22,634	278,254	411,380	1,741	4,987	3,824	274	422,206
C- - -	7,642	3,727	4,057	1,369	15,932	32,727	217	453	-----	6	33,403
D- - -	36,519	18,653	28,098	19,471	241,916	344,657	1,449	4,073	694	243	351,116
E- - -	1,099	458	1,113	114	4,088	6,872	29	78	-----	---	6,979
F- - -	6,069	3,286	4,840	1,035	21,750	36,980	194	488	-----	36	37,698
G- - -	2,451	989	2,373	668	8,195	14,676	66	122	-----	1	14,865
H- - -	2,019	1,324	1,653	435	4,989	10,420	72	163	-----	14	10,669
I- - -	1,567	1,128	1,044	386	8,770	12,895	30	161	5	---	13,091
J- - -	3,070	1,157	1,864	1,066	18,295	25,452	42	268	-----	---	25,762
K- - -	2,704	1,176	1,934	1,357	38,814	45,985	78	421	-----	---	46,484
L- - -	2,494	886	1,825	1,314	28,198	34,717	63	261	-----	1	35,042
M- - -	1,519	1,100	2,049	756	11,970	17,394	42	166	-----	---	17,602
N- - -	3,125	2,271	4,067	3,571	33,617	46,651	85	458	-----	4	47,198
O- - -	2,872	1,152	1,851	5,961	34,357	46,193	263	777	80	149	47,462
Total- -	176,568	90,226	129,340	84,109	1,038,017	------	6,342	18,169	8,623	1,002	1,552,396

TABLE 21.--Land use summary, Medicine Creek Watershed, Nebr., 1954

Subwatershed	Row crop	Small grain	Fallow	Hay	Pasture or range	Subtotal	Farmsteads	Roads	Streams and lakes	Trees
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
A- - -	12.18	6.17	8.39	5.41	65.23	97.39	0.45	1.20	0.91	0.06
B- - -	11.72	6.06	8.39	5.36	65.91	97.44	.41	1.18	.91	.06
C- - -	22.88	11.16	12.14	4.10	47.70	97.98	.64	1.36	---	.02
D- - -	10.40	5.31	8	5.55	68.90	98.16	.41	1.16	.20	.07
E- - -	15.75	6.56	15.95	1.63	58.58	98.47	.41	1.12	---	---
F- - -	16.10	8.72	12.84	2.74	57.70	98.10	.51	1.29	---	.10
G- - -	16.49	6.66	15.96	4.49	55.13	98.73	.44	.82	---	.01
H- - -	18.92	12.41	15.49	4.08	46.77	97.67	.67	1.53	---	.13
I- - -	11.97	8.61	7.97	2.95	67	98.50	.23	1.23	.04	---
J- - -	11.92	4.49	7.24	4.14	71.01	98.80	.16	1.04	---	---
K- - -	5.82	2.53	4.16	2.92	83.50	98.93	.17	.90	---	---
L- - -	7.12	2.53	5.21	3.75	80.47	99.08	.18	.74	---	---
M- - -	8.63	6.25	11.64	4.30	68	98.82	.24	.94	---	---
N- - -	6.62	4.81	8.62	7.57	71.22	98.84	.18	.97	---	.01
O- - -	6.05	2.43	3.90	12.56	72.39	97.33	.55	1.64	.17	.31

TABLE 22.--Land use summary, Medicine Creek Watershed, Nebr., 1955

Subwatershed	Row crop	Small grain	Fallow	Hay	Pasture or range	Subtotal	Farmsteads	Roads	Streams and lakes	Trees	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
A- - -	47,616	33,722	39,638	20,897	287,819	429,692	3,561	5,293	3,965	308	442,819
B- - -	43,949	31,806	37,021	19,493	277,488	409,757	3,319	4,987	3,835	308	422,206
C- - -	6,659	4,192	4,626	1,433	15,766	32,676	270	453	-----	4	33,403
D- - -	32,286	24,443	28,574	16,103	241,741	343,147	2,966	4,073	634	296	351,116
E- - -	906	895	855	175	4,043	6,874	27	78	-----	---	6,979
F- - -	5,352	4,020	4,863	1,068	21,726	37,029	142	488	-----	39	37,698
G- - -	2,643	1,760	1,823	420	8,025	14,671	70	122	-----	2	14,865
H- - -	1,526	1,901	1,600	430	4,968	10,425	72	163	-----	9	10,669
I- - -	1,593	1,007	1,156	375	8,759	12,890	44	157	-----	---	13,091
J- - -	2,229	1,663	2,015	980	18,558	25,445	50	267	-----	---	25,762
K- - -	2,113	1,685	2,046	1,388	38,744	45,976	88	420	-----	---	46,484
L- - -	2,099	1,750	1,646	1,106	28,081	34,682	59	261	38	2	35,042
M- - -	1,641	1,426	1,824	658	11,844	17,393	43	166	-----	---	17,602
N- - -	2,453	3,209	4,326	3,052	33,611	46,651	85	458	-----	4	47,198
O- - -	2,578	1,802	1,928	3,659	36,181	46,148	282	783	78	171	47,462
Total- -	155,643	115,281	133,941	71,237	1,037,354	1,513,456	11,078	18,169	8,550	1,143	1,552,396

TABLE 23.--Land use summary, Medicine Creek Watershed, Nebr., 1955

Subwatershed	Row crop	Small grain	Fallow	Hay	Pasture or range	Subtotal	Farmsteads	Roads	Streams and lakes	Trees
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
A- - -	10.75	7.61	8.95	4.72	65	97.03	0.80	1.20	0.90	0.07
B- - -	10.41	7.53	8.77	4.62	65.72	97.05	.79	1.18	.91	.07
C- - -	19.94	12.55	13.85	4.29	47.20	97.83	.81	1.35	---	.01
D- - -	9.20	6.96	8.14	4.59	68.85	97.74	.84	1.16	.18	.08
E- - -	12.98	12.82	12.25	2.51	57.93	98.49	.39	1.12	---	---
F- - -	14.20	10.66	12.90	2.83	57.63	98.22	.38	1.30	---	.10
G- - -	17.78	11.84	12.26	2.83	53.99	98.70	.47	.82	---	.01
H- - -	14.30	17.82	15	4.03	46.56	97.71	.68	1.53	---	.08
I- - -	12.17	7.69	8.83	2.86	66.91	98.46	.34	1.20	---	---
J- - -	8.65	6.46	7.82	3.80	72.04	98.77	.19	1.04	---	---
K- - -	4.55	3.62	4.40	2.99	83.35	98.91	.19	.90	---	---
L- - -	5.99	4.99	4.70	3.16	80.13	98.97	.17	.74	.11	.01
M- - -	9.32	8.10	10.36	3.74	67.29	98.81	.25	.94	---	---
N- - -	5.20	6.80	9.16	6.47	71.21	98.84	.18	.97	---	.01
O- - -	5.43	3.80	4.06	7.71	76.23	97.23	.60	1.65	.16	.36

TABLE 24.--Land use summary, Medicine Creek Watershed, Nebr., 1956

Subwatershed	Row crop	Small grain	Fallow	Hay	Pasture or range	Subtotal	Farmsteads	Roads	Streams and lakes	Trees	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
A- - -	49,422	39,484	38,436	17,437	285,910	430,689	2,473	5,293	4,121	243	442,819
B- - -	45,190	37,125	36,132	16,652	275,797	410,896	2,162	4,987	3,923	238	422,206
C- - -	5,861	5,108	4,686	1,048	15,953	32,656	272	453	-----	22	33,403
D- - -	34,167	27,695	28,446	13,872	240,072	344,252	1,759	4,073	875	157	351,116
E- - -	1,175	971	675	109	3,945	6,875	26	78	-----	---	6,979
F- - -	5,553	4,373	4,486	1,037	21,545	36,994	166	488	-----	50	37,698
G- - -	2,414	2,025	1,900	367	7,964	14,670	71	122	-----	2	14,865
H- - -	1,715	1,672	1,822	151	5,038	10,398	103	163	-----	5	10,669
I- - -	1,794	996	1,015	306	8,761	12,872	62	157	-----	--	13,091
J- - -	2,649	1,669	1,954	562	18,606	25,440	55	267	-----	--	25,762
K- - -	2,000	1,872	1,969	1,571	38,533	45,945	92	420	25	2	46,484
L- - -	1,955	1,732	2,046	1,206	27,760	34,699	80	261	-----	2	35,042
M- - -	1,369	1,798	1,855	552	11,798	17,372	64	166	-----	---	17,602
N- - -	2,585	3,608	4,283	2,504	33,573	46,553	172	458	-----	15	47,198
O- - -	2,392	2,465	2,089	3,357	35,814	46,117	314	783	205	43	47,462
Total- -	160,241	132,593	131,794	60,731	1,031,069	1,516,428	7,871	18,169	9,149	779	1,552,396

TABLE 25.--Land use summary, Medicine Creek Watershed, Nebr., 1956

Subwatershed	Row crop	Small grain	Fallow	Hay	Pasture or range	Subtotal	Farmsteads	Roads	Streams and lakes	Trees
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
A- - -	11.16	8.92	8.68	3.94	64.56	97.26	0.56	1.20	0.93	0.05
B- - -	10.70	8.79	8.56	3.95	65.32	97.32	.51	1.18	.93	.06
C- - -	17.55	15.29	14.03	3.14	47.76	97.77	.81	1.35	---	.07
D- - -	9.73	7.89	8.10	3.95	68.37	98.04	.50	1.16	.25	.05
E- - -	16.84	13.91	9.67	1.56	56.53	98.51	.37	1.12	---	---
F- - -	14.73	11.60	11.90	2.75	57.15	98.13	.44	1.30	---	.13
G- - -	16.24	13.62	12.78	2.47	53.58	98.69	.48	.82	---	.01
H- - -	16.07	15.67	17.08	1.42	47.22	97.46	.96	1.53	---	.05
I- - -	13.71	7.61	7.75	2.34	66.92	98.33	.47	1.20	---	---
J- - -	10.28	6.48	7.59	2.18	72.22	98.75	.21	1.04	---	---
K- - -	4.30	4.03	4.24	3.38	82.89	98.84	.20	.90	.05	.01
L- - -	5.58	4.94	5.84	3.44	79.22	99.02	.23	.74	---	.01
M- - -	7.78	10.21	10.54	3.14	67.03	98.70	.36	.94	---	---
N- - -	5.48	7.64	9.07	5.31	71.13	98.63	.37	.97	---	.03
O- - -	5.04	5.20	4.40	7.07	75.46	97.17	.66	1.65	.43	.09

TABLE 26.--Land use summary, Medicine Creek Watershed, Nebr., 1957

Subwatershed	Row crop	Small grain	Fallow	Hay	Pasture or range	Subtotal	Farmsteads	Roads	Streams and lakes	Trees	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
A- - -	49,074	34,078	43,367	16,204	288,079	430,802	2,439	5,293	4,046	239	442,819
B- - -	44,751	32,648	40,562	15,092	277,970	411,023	2,114	4,987	3,848	234	422,206
C- - -	6,960	4,436	4,369	942	15,959	32,666	274	453	-----	10	33,403
D- - -	32,644	25,761	31,733	12,014	242,182	344,334	1,710	4,073	834	165	351,116
E- - -	1,181	698	942	124	3,930	6,875	26	78	-----	---	6,979
F- - -	4,967	4,251	5,444	864	21,467	36,993	170	488	-----	47	37,698
G- - -	2,091	2,090	2,265	207	8,016	14,669	74	122	-----	---	14,865
H- - -	1,642	1,609	1,839	294	5,017	10,401	100	163	-----	5	10,669
I- - -	1,244	1,263	1,279	243	8,842	12,871	63	157	-----	---	13,091
J- - -	2,525	1,697	2,078	481	18,652	25,433	62	267	-----	---	25,762
K- - -	2,238	1,618	2,256	1,145	38,690	45,947	92	420	25	---	46,484
L- - -	1,800	2,103	1,791	993	28,013	34,700	79	261	-----	2	35,042
M- - -	1,716	1,401	1,987	483	11,800	17,387	49	166	-----	---	17,602
N- - -	3,127	3,325	4,823	1,774	33,526	46,575	150	458	-----	15	47,198
O- - -	2,665	1,760	2,515	3,285	35,896	46,121	313	783	199	46	47,462
Total- -	158,625	118,738	147,250	54,145	1,038,039	1,516,797	7,715	18,169	8,952	763	1,552,396

TABLE 27.--Land use summary, Medicine Creek Watershed, Nebr., 1957

Subwatershed	Row crop	Small grain	Fallow	Hay	Pasture or range	Subtotal	Farmsteads	Roads	Streams and lakes	Trees
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
A- - -	11.08	7.70	9.79	3.66	65.06	97.29	0.55	1.20	0.91	0.05
B- - -	10.60	7.73	9.61	3.57	65.84	97.35	.50	1.18	.91	.06
C- - -	20.84	13.28	13.08	2.82	47.78	97.80	.82	1.35	---	.03
D- - -	9.30	7.34	9.04	3.42	68.97	98.07	.49	1.16	.24	.04
E- - -	16.92	10	13.50	1.78	56.31	98.51	.37	1.12	---	---
F- - -	13.18	11.28	14.44	2.29	56.94	98.13	.45	1.30	---	.12
G- - -	14.07	14.06	15.24	1.39	53.92	98.68	.50	.82	---	---
H- - -	15.39	15.08	17.24	2.76	47.02	97.49	.94	1.53	---	.04
I- - -	9.50	9.65	9.77	1.86	67.54	98.32	.48	1.20	---	---
J- - -	9.80	6.59	8.06	1.87	72.40	98.72	.24	1.04	---	---
K- - -	4.82	3.48	4.85	2.46	83.23	98.84	.20	.90	.06	---
L- - -	5.14	6	5.11	2.83	79.94	99.02	.23	.74	---	.01
M- - -	9.75	7.96	11.29	2.74	67.04	98.78	.28	.94	---	---
N- - -	6.63	7.04	10.22	3.76	71.03	98.68	.32	.97	---	.03
O- - -	5.61	3.71	5.30	6.92	75.63	97.17	.66	1.65	.42	.10

TABLE 28.--Unmeasured sediment transport computed from instantaneous values, Medicine Creek Watershed, Nebr.

Dry Creek near Curtis

Runoff discharge	Sediment concentration	Measured sediment	Percent coarser than 62 micron	Colby's Method		Maddock's Table
				Unmeasured sediment	Ratio of unmeasured to measured	Ratio of unmeasured to measured
C.F.s	P.p.m.	Tons/day	Percent	Tons/day		
20	11,000	593	6	28	0.048	0.02-0.08
420	58,400	66,102	12	2,301	.035	
3,370	57,400	521,815	4	7,560	.015	
719	72,000	139,515	10	5,290	.038	
415	58,200	65,092	9	1,758	.027	
104	20,300	5,690	1	65	.011	
710	39,800	76,155	7	2,063	.027	
170	25,600	11,729	3	242	.021	
Brushy Creek near Maywood						
461	28,600	35,532	6	832	.023	0.02-0.08
28	9,520	718	2	22	.031	
598	14,300	23,046	4	635	.028	
1,440	24,100	93,527	6	1,476	.016	
486	32,400	42,437	2	382	.009	
360	10,500	10,187	2	94	.009	
370	15,400	15,356	7	285	.019	
Mitchell Creek above Harry Strunk Lake						
1,390	18,200	68,178	1	335	.005	0.02-0.08
212	45,300	25,882	3	431	.017	
964	25,700	66,768	2	1,173	.018	
1,180	11,000	34,685	2	765	.022	
341	28,600	26,283	4	330	.013	
308	66,900	55,531	4	777	.014	
156	31,800	13,369	3	581	.043	

TABLE 28.--Continued

Medicine Creek at Maywood						
238	2,300	1,480	7	92	.062	0.05-0.12
23	226	14	0	0	0	0
75	2,790	560	3	22	.039	0.05-0.12
100	1,640	440	5	26	.059	
13	204	7	1	1	0	0
11	199	6	1	1	0	0
14	310	12	2	1	0	0
63	3,300	560	3	29	.052	0.05-0.12
27	318	23	7	5	.217	
74	4,490	900	4	40	.044	
94	11,800	2,990	2	54	.018	0.02-0.08
95	2,140	550	7	39	.07	0.05-0.12
128	14,800	5,110	4	110	.022	0.02-0.08
Medicine Creek above Harry Strunk Lake						
63	540	92	23	37	.402	0.25-1.50
180	6,380	3,100	4	170	.055	0.05-0.12
65	1,450	250	2	19	.076	
180	6,150	2,990	5	160	.054	0.02-0.08
19	110	6	4	0	0	
19	123	6	2	0	0	
123	8,000	2,660	2	78	.029	
26	135	9	7	5	.556	0.05-0.12
783	12,000	25,400	4	890	.035	0.02-0.08
2,090	12,400	70,000	2	750	.011	
48	744	96	2	12	.125	0.05-0.12
143	4,610	1,180	1	52	.029	
111	4,500	1,350	6	100	.074	
1,070	13,600	39,300	6	1,500	.038	0.02-0.08
108	2,520	730	4	52	.071	
111	3,480	1,040	9	99	.095	
95	1,230	310	3	22	.071	0.05-0.12